POPULAR SCIENCE MONTHLY

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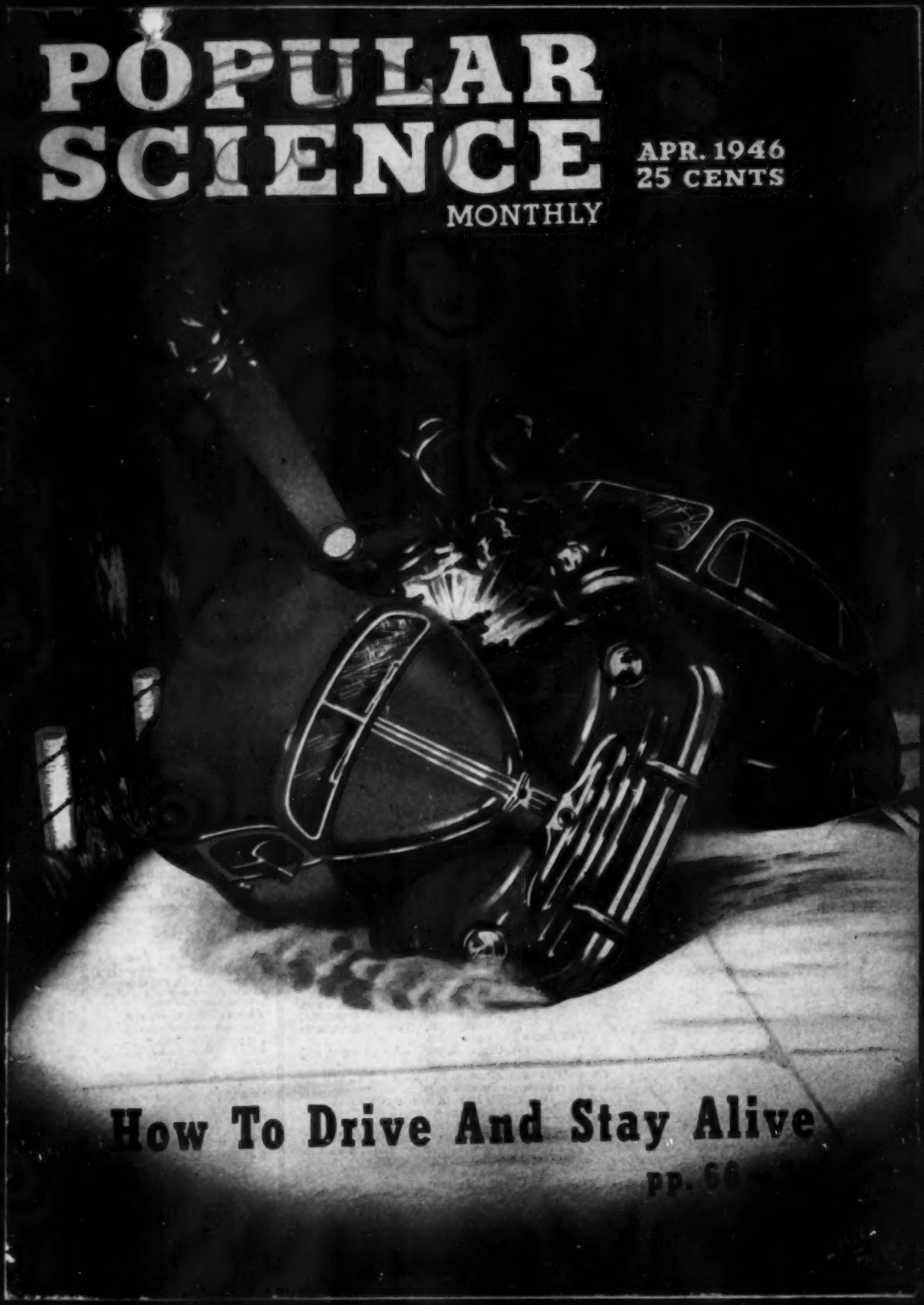

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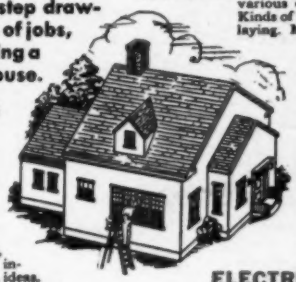

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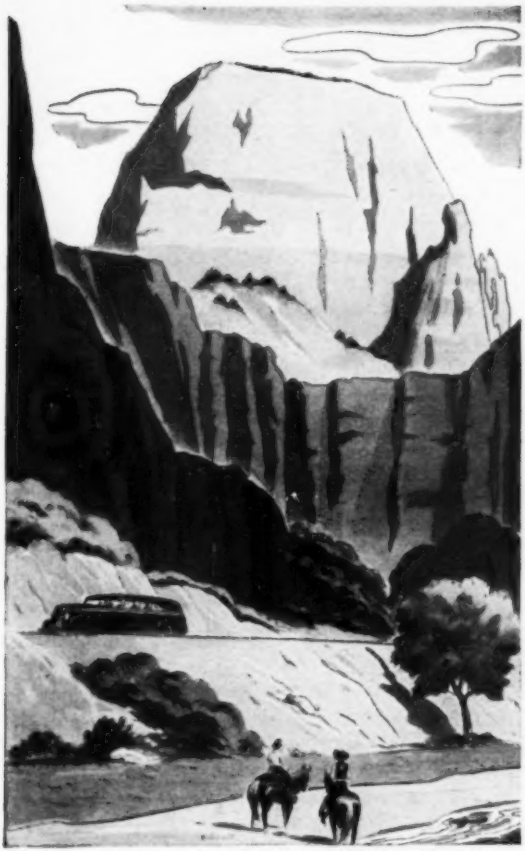

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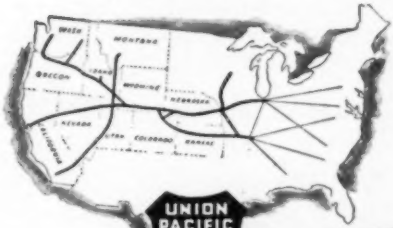

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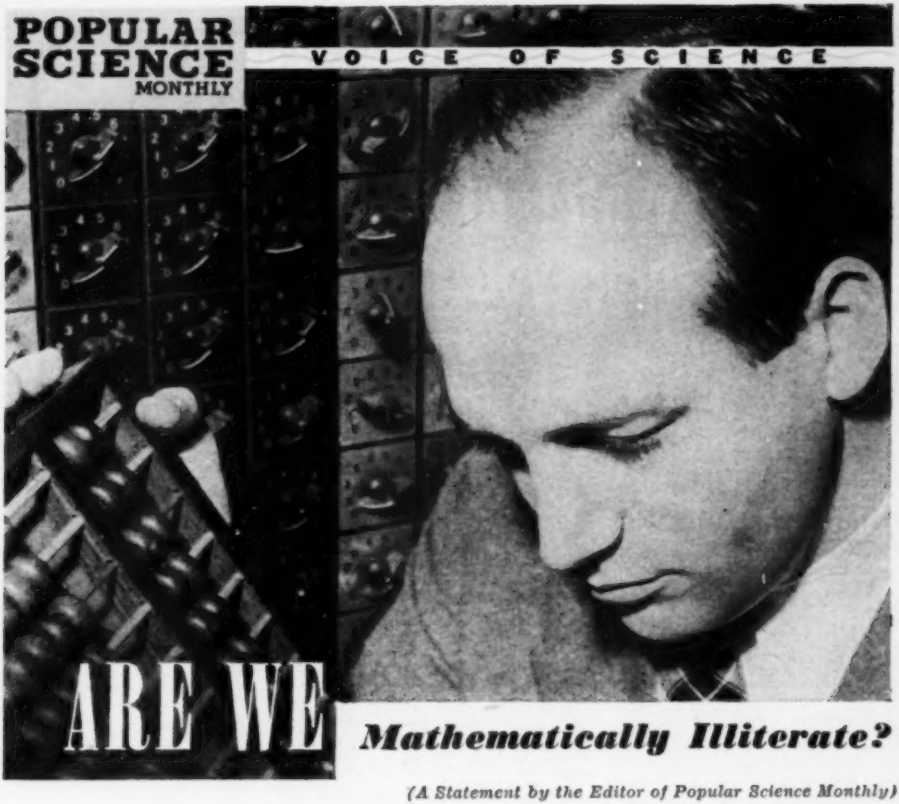

ARE WE *Mathematically Illiterate?*

(A Statement by the Editor of Popular Science Monthly)

MEET Dr. Eckert. He is standing in front of the set-up switches of the Eniac—the light-quick electronic calculator he helped to invent. He is holding an abacus—the primitive counting machine.

Most of us know the abacus as a children's toy. Few of us can comprehend the immense scope and usefulness of the Eniac. The picture dramatizes the lag in this country between mathematical accomplishment and public understanding.

It is no secret to scientists, bank tellers, Army and Navy officers, and machine shop foremen that we Americans are poor at figures. The Army found U. S. youngsters high in native intelligence and mechanical competence, but shockingly low in simple arithmetic. The Navy, training flyers to find their way home, had to backtrack navigation into high school mathematics with special catch-up courses.

Why should a nation that is so handy with machines be so backward in the handling of the principles that make modern living possible? Perhaps part of the fault lies less with the subject than with the object of our schooling. For years the three R's have misspelled the personal importance of mathematics. Arithmetic has been used as a whip for the slow-minded, and a discipline to dull the bright. Any mathematics beyond bank statements and tax returns is damned as theoretical.

Certainly, mathematics is anything but theoretical in the remote, never-touched-me sense. Since Einstein projected theory into a cosmic curve that crossed the earth in New Mexico and Nagasaki, it has become frighteningly practical. Digits, these days, are as vital in communication as the alphabet. The world as we live it is conducted increasingly in mathematical terms. We call them kilowatt hours, board feet, miles per hour, pay per day. A better understanding of mathematics means better living in terms as personal as a mattress. We know now that money is mathematics, not metal.

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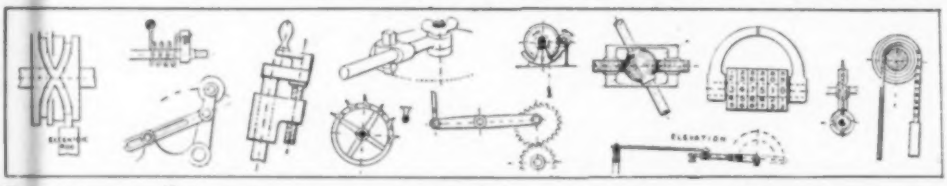

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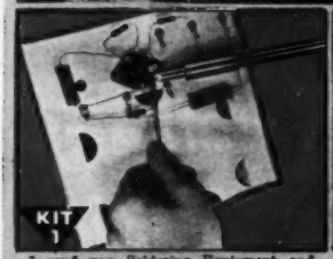

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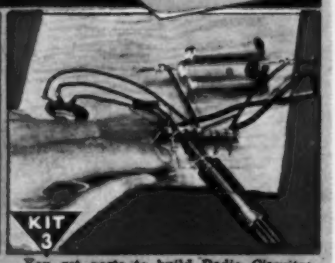

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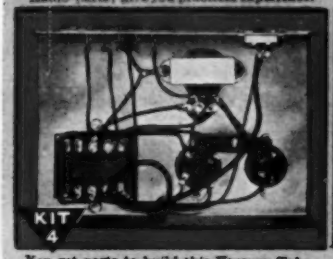

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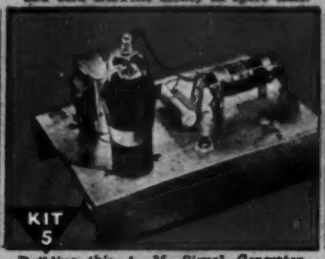

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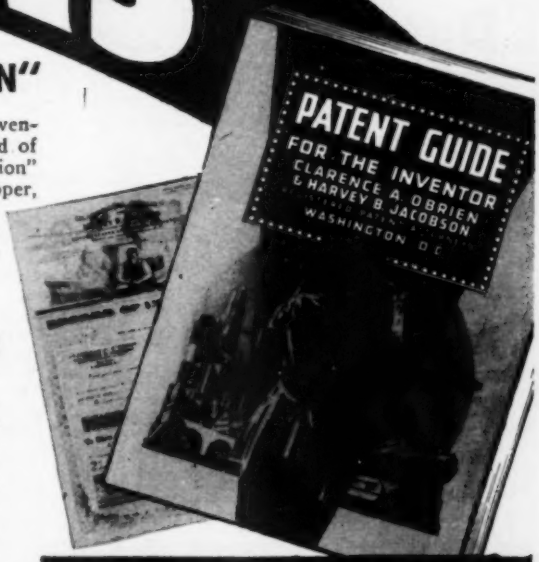

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Amen!

Sir:

The reserve for the Navy and the nation in any future emergency must be drawn from scientific and technical personnel. The advent of weapons of destruction that can be manned by few people, pilotless planes carrying deadly charges, bacterial warfare; in fact, the countless horrors of a possible future war point clearly to the need of a scientific reserve rather than a lot of foot soldiers who may never get a chance to come to grips with the enemy . . . .

The war has depleted our stock of technical men by withdrawing them from scientific college courses and putting them into the Services. Just how many of them will return to their technical work cannot be predicted but the possibility is that our loss will be substantial and permanent. Not only must we make up this deficit but we must produce sufficient additional scientific talent to cope with a world which is daily becoming more complicated and in which technical competition among nations will doubtless become more vigorous as time goes on. It is extremely dangerous to allow the knowledge of a relatively small group only to increase. Our aim should be to increase the over-all general level of technical education—disseminating scientific information as widely as possible.

LUIS de FLOREZ

Wash., D. C. Rear Admiral, U.S.N.R.

Rear Admiral de Florez, noted mechanical and chemical engineer whose inventions include an oil-cracking process and blind-flying methods, and who spark-plugged Navy science during the war, eloquently expresses Popular Science Monthly's belief that scientific information must be disseminated more widely.

Home-Made Aircraft

Sir:

Why doesn't Popular Science organize a section for industrious readers like myself who would like to build their own planes?

BILL GRIFFITHS

Douglas, Ariz.

Consider the difficulties: Anyone desiring to build a "cellar" airplane must be a U. S. citizen, register his project with the Civil Aeronautics Authority and be assigned a number. If he has had no experience with materials or design, he must bear the expense of C. A. A. inspection. Then, before

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Science Before Guns?

Sir:

You will have done a tremendous service to American scientific progress if you convince your readers of two basic facts: that the scientist is a normal human being, doing a good job in a necessary and difficult field, and that science is not mystery and magic so much as common sense and hard work.

In spite of the recent achievements of military and medical science there still is a widespread misconception among lay readers that the scientist is an eccentric and rather expensive luxury. Our draft boards clearly reflected this misunderstanding in their conviction that in wartime the younger generation of scientists and science trainees were worth more to the country for their muscles than for their minds.

K. STARR CHESTER
Chairman, Pub. Rel. Comm.
American Phytopathological Society

Happily, American scientists now seem well on their way to receiving long-deserved recognition, both from military and civil authorities.

DDT Don'ts

Sir:

As part of your article on DDT (PSM, Feb. '46, p. 74) there was a box in a yellow border headed "Don't Do This." We thought it so good that we would like to submit it to our seven county weekly newspapers. May we have your permission to do so?

R. J. DALTON, M. D.
Tavares, Fla.

Permission has been granted.

Frog Feet

Sir:

Could you tell me where to get the foot fins mentioned in the article, "Frog Men," published in PSM for December 1945?

J. D. K.
Brooklyn, N. Y.

The Office of Surplus Property, 350 Fifth Ave., New York, N. Y., recently reported that complete frog-men outfits had not been released for bids. But larger sporting-goods stores have had similar foot flippers for swimmers in stock. For further information about this equipment, see "Fun Under Water," on page 113 of this issue.

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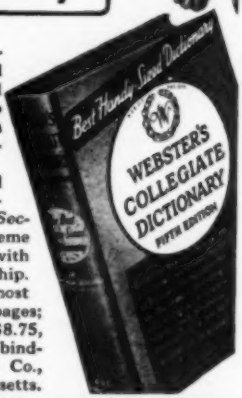

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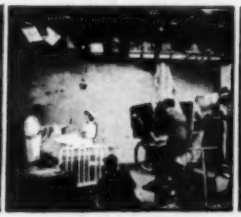

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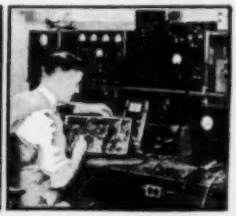

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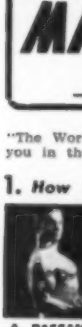

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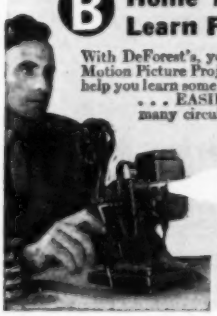

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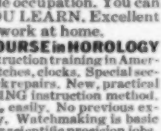

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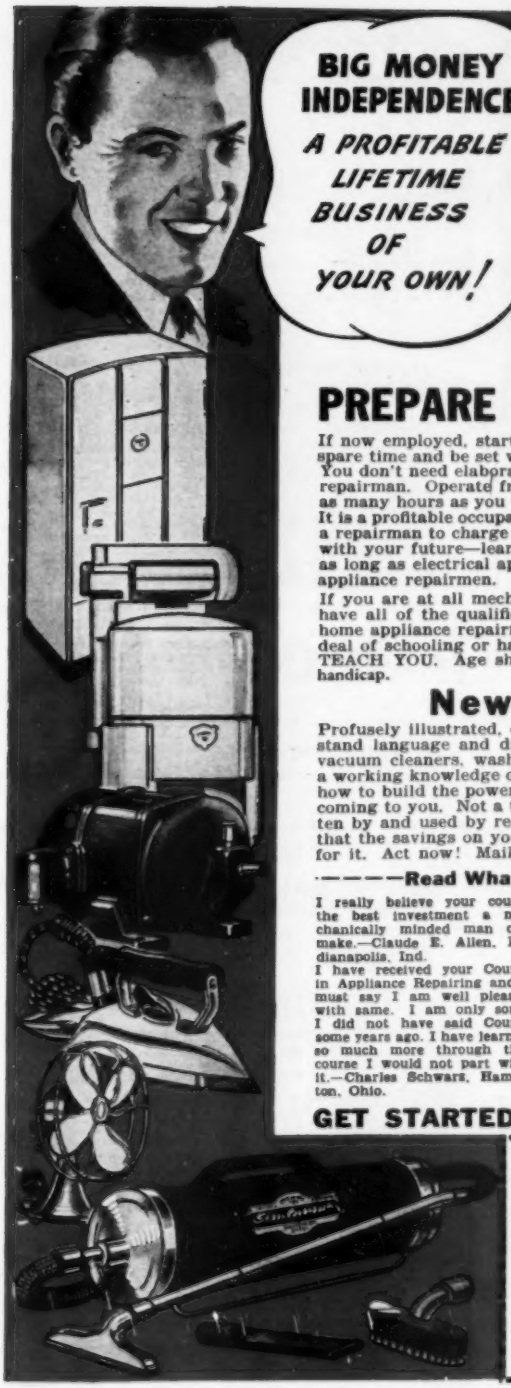

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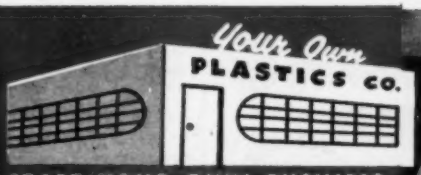

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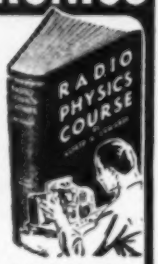

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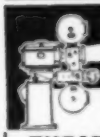

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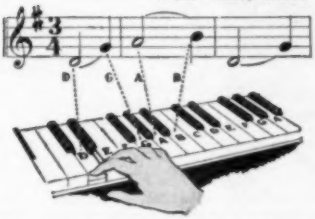

Look at the diagram. The first note of the music is "D." Following the dotted line to the keyboard you'll find "D" is the white key between the two black keys near the middle of the keyboard. Now read below how you can learn to play any instrument quickly and easily.

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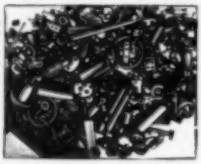

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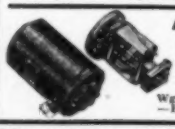

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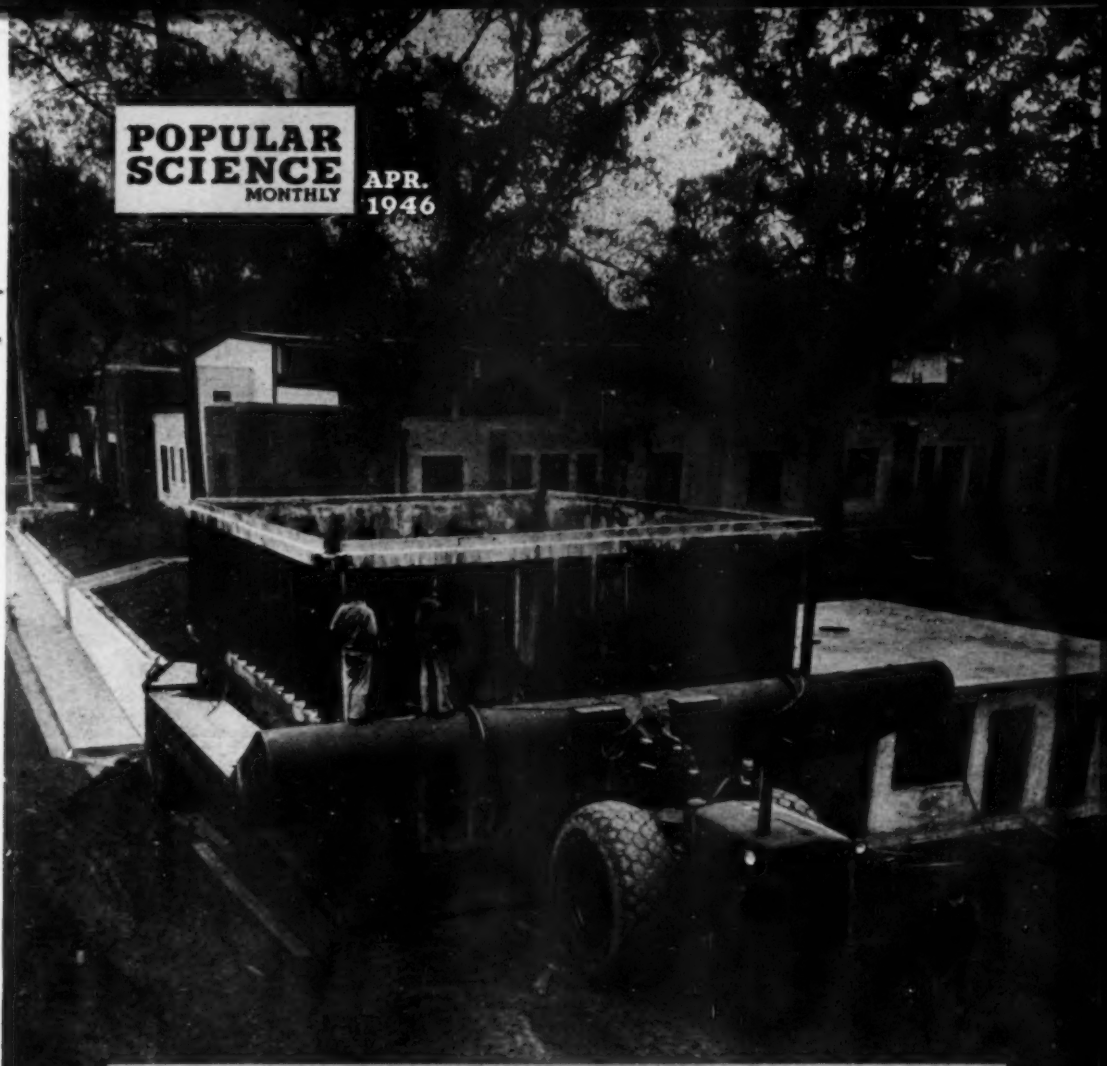
APR. 1946



MONSTER MECHANICAL HEN LAYS WHOLE HOUSE AT ONCE

The Tournalayer, latest product of R. G. Le Tourneau, the big earth-moving man, can produce four-room concrete houses by the dozen. Squatting on a steel-mesh inside form, it pours concrete to make walls with doors and windows. Flat roofs are laid like pavement. When the mix is dry, the inside form is collapsed, and the huge steel hen trundles the 24- by 30- by 9½-foot house to its foundation. At the press of a button, the outside shell lifts off, leaving the house ready for finishing. Then the Tournalayer waddles away to gulp another charge of concrete.

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By DEVON FRANCIS

BEFORE you finish this article one person will be killed and some 40 will be injured in automobile and truck accidents in the United States.

This is the average of traffic casualties every 15 minutes, day and night, winter and summer. Actually, deaths on U. S. streets and highways between Pearl Harbor and V-J Day were more than a third of the total U. S. combat deaths in World War II.

Now the accident rate involving automotive vehicles, which dropped sharply with gasoline rationing during the war years, is skyrocketing again. Organizations dedicated to spreading the gospel of safe driving are worried. Even though there are 4,000,000 fewer cars on the road now than there were before the war, experts expect 1946 to exceed the peak year of 1941 when nearly 40,000 persons were killed and 1,450,000 injured. This fear has prompted President Truman to call a national safety conference for May 8 to 10.

The authorities' worries are justified. Traffic casualties for 1945 were up 17 percent from the previous year, *and almost all of that increase occurred in the four months following V-J Day.* In October alone there were more than 100 deaths a day.

The brakes were off.

Basic causes were simple: roads had deteriorated during the war; cars were out of repair and their average age was more than eight years; speed ceilings were lifted; but, most of all, drivers once again were unfettered and careless.

More subtle reasons were also advanced. Drivers were four years older than they were when gasoline rationing and speed limits were imposed. Millions of them discovered that their emergency nervous-muscular reaction time had slowed up.

But, as always, most of the accidents resulted from plain "left-front-seat trouble."

Better roads will be built. Old roads will be mended. New cars are coming. New tires are available. But until you, as an automobile driver, exercise judgment and caution and skill in that left front seat, the accident toll will continue to go up. The purpose of this special section of *Popular Science Monthly* is to acquaint you with what *you* can do about accidents to protect yourself, your family, and your car.

Tests in Cleveland have proved that better understanding and training make for safer driving. Using a "controlled" group of 3,252 high school students as guinea pigs,

Cleveland authorities cut traffic accidents in half in a given period. Some of the students were educated in good driving habits. Some were not. Educational campaigns in other cities have added to the evidence.

Most accidents are caused by faulty judgment, an effort to beat the traffic light, too heavy a foot on the accelerator, and a lack of appreciation of (a) a human being's limitations and (b) an automobile's limitations.

The man behind the wheel does not stop to think that elementary physics governs the controllability of his car. It is subject to friction in accelerating and braking, to gravity in going up and down hills, to centrifugal force in rounding a turn, and to force of impact if it collides with something. The force of impact goes up as the *square* of the speed—you will hit an obstruction *four times as hard* at 40 miles an hour as you will at 20.

Even if your reaction time is normal, it will take you three quarters of a second to jam on the brake after your eye telegraphs your nervous system that you are about to hit something. At 10 miles an hour, this three quarters of a second plus braking time will carry you 17 feet before you stop—even on dry, high-friction concrete. At 50 miles an hour, three quarters of a second mean 172 feet, or more than half the length of an average city block.

Speed cannot be blamed, however, for any given share of accidents. It is speed "too fast for conditions" that causes trouble on the street and open road. An arbitrary speed limit set for a specific road on a sunny summer day must be revised for a rainy day and again for a snowy day. Then further revisions must be made for individual eccentricities of the cars using the road. A car with good brakes and tires on dry concrete has 11 times the "grip" for stopping that a car has on ice, with equally good brakes but a smooth tread.

The accident curve, by the way, mounts progressively as the good weather months merge into the bad weather months.

Speed, again, is a function of judgment in the left front seat.

You may not know how darkness shoots up the hazards of driving. The National Safety Council, devoted to preventing all kinds of accidents, estimates that three fifths of all traffic fatalities occur during dusk and darkness. At best, the eye has a dubious sensitivity at night. The average automobile's headlights give a driver with good eyesight a clear view of the road for only 100 feet ahead—and it still takes 172 feet to stop at 50 miles an hour, whether you are driving at high noon or at midnight.

The commonest type of fatal accident is an auto hitting a pedestrian. Yet pedestrians figure in only two out of five traffic deaths and in only one out of four nonfatal injuries. You are in more danger as the occupant of

For 27 years, Jacob Capria has driven a cab on the crowded streets of New York; yet none of his passengers has ever had even a minor injury. An average cab driver would have had nine personal-injury accidents in that time.

Capria's safe driving, which earned him a commendation scroll from Taxi Weekly, *is based on these few simple rules:*

"Speeding just ain't worth it.

"Always drive in a straight line—this cutting-in-and-out stuff is bad.

"Always wait for the last car to get across when the light changes."

Jay walkers are the cab driver's major peril, says Capria.

"'Keep your eyes up, lady,' I tell 'em."

Car hits pedestrian at intersection.

Car hits jaywalker between intersections.

COMMONEST ACCIDENT PATTERNS

an accident-bound automobile than you are afoot as an automobile target.

In both metropolitan and rural areas a third of all pedestrian deaths occur between intersections. In rural districts another third happen because people refuse to take precautions while walking in the roadway. Roadway walking is much less of a problem in cities, but more than a quarter of pedestrian deaths in cities happen at intersections where there are no traffic lights. The pedestrian, too, is your responsibility as a driver.

Pick your age group among drivers and you can tell pretty well what your chances are of being in an accident. The dangerous age for drivers is 16 to 20. This age group has *twice as many accidents* and *five times as many fatal accidents* as older drivers.

If your son is 16, he and his fellow-sixteeners will drive only 2,000,000 miles this year for every fatal accident. For a man between 20 and 25, the figure jumps to 8,000,000 miles. If you are between 45 and 50, you are more accident-proof than you ever have been in your life, or will be until you die. This age group, having good reaction time plus caution born of experience,

Right-angle collision at intersection.

Head-on collision at intersection.

Head-on collision on open road.

Over the often treacherous Ridge Route between Los Angeles and Fresno, William P. Huffman has driven Greyhound busses 1,000,000 miles in the last 10 years, safely delivering 1,000,000 passengers to their destinations. Huffman gives two reasons for his safety record:

"I drive no faster than the weather, the road conditions, and the mechanical condition of my bus will permit.

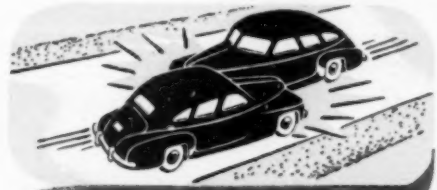
"On clear days I usually drive at least half a mile ahead of the windshield, trying to anticipate what cars in both lanes of traffic are going to do. By doing this I'm not forced to keep such a close watch on the immediate vicinity, and thus avoid ducking, maneuvering violently, and coming to sudden stops."

G. J. Finch, of Boston's Ladder Company No. 4, drives an 85-foot aerial ladder truck. In 28 years he has driven 40,000 miles through narrow, winding streets without an accident—and never been late to a fire.

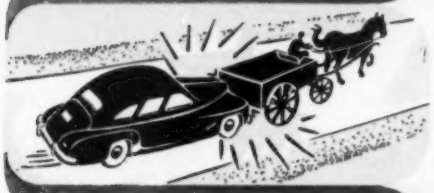
"I just don't take chances," Finch declares. "And I always go slow enough to stop in any emergency. Our job is to protect the public. If we get to a fire before the other fellow but have an accident on the way, then we are letting the public down."

The 54-year-old fireman is "suspicious" of every driver on the road.

"So," he says, "by driving slow I avoid accidents with them no matter what they take it into their heads to do."



Sideswipe on open road.



Collision with horse-drawn vehicle on open road.

Collision with cow on open road.

drives more than 21,000,000 miles for every fatal accident.

Additional regulation may help. Three states—Wyoming, Louisiana, and South Dakota—do not even require drivers' licenses. From 20 to 30 others, according to the American Automobile Association, conduct only perfunctory tests for licenses. Often courts are lax in imposing penalties.

But any program for accident prevention turns inevitably on the further education of the driver. Accidents *can* be prevented. They can be if you, as a driver, refuse to subscribe to the myth that it requires no preparation to drive a mechanical device with 500 times the horsepower of the man at its controls. A steering wheel, clutch, brake, and accelerator are your only reins on this mechanical monster.

DON'T forget the deadly physics of speed: 30 m.p.h. plus 30 m.p.h. equals driving off a nine-story building.

DON'T forget that 150 lb. of human can't stand up to 3,000 lb. of car—whether you are inside or in front of the car.

DON'T figure on the other fellow doing the right thing: do it yourself.

DON'T pass on any bad driving habits in teaching others: write your insurance company for a manual of correct teaching

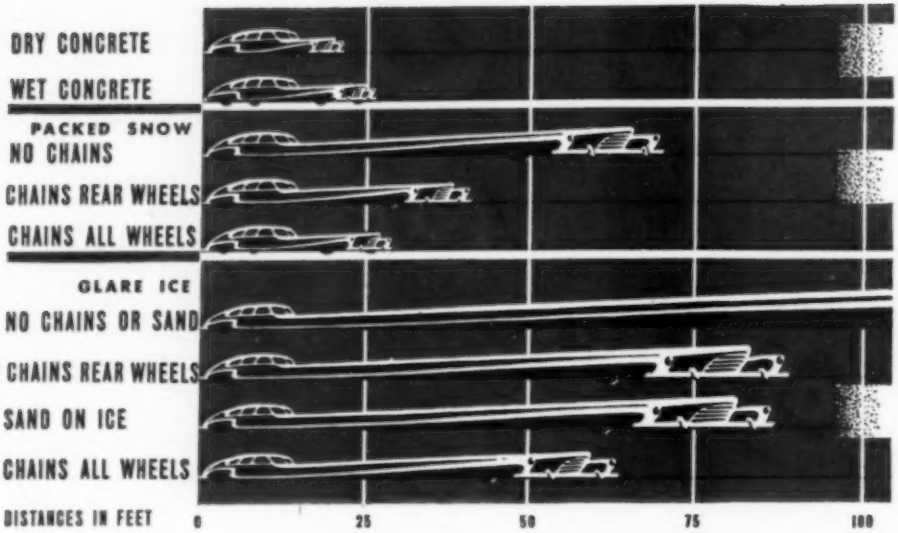
Car leaves road on curve and overturns.

Car leaves straight road and overturns.

Safe driving is not so much a matter of how fast you go but how steady your speed is, reports Harry Cavalier, of Chicago, who has driven a big truck 315 miles a day, five days a week, for more than five years—and has yet to exceed 45 m.p.h. He has never had an accident.

"Under good road conditions, we cruise between 40 and 45. That's a sane and relaxing speed. And by keeping it steady, we make time.

"I slow down to 20 in fog, and going through towns. Traffic lights and stop signs, I observe—but good. I don't monkey with amber lights, and even when they're green I slow down; that's the only way to grow old in this business. I won't pass a car within 100 yards of a curve."



TEST YOURSELF FOR SAFE

HANDICAPPED persons are often the safest drivers, because they know their weaknesses and make up for them. You can do the same. With these simple, homemade tests you can get a line on your physical condition, driving knowledge and judgment.

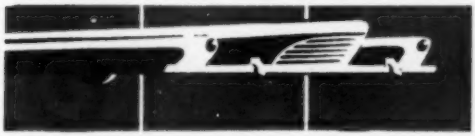
The test gadgets are easy to build, but because yours will not be quite like anyone else's, we cannot provide a standard scale for scoring. If you can't do as well as your friends do on the tests, try to correct your driving deficiency or at least allow for it.

TEST YOUR PERIPHERAL VISION—that's the important ability to see things coming from the side when you are looking straight ahead—with a cardboard protractor having a radius of 10 inches. Sit with the bridge of your nose in a slot notched in the protractor while someone behind you moves a bright object from the rear along one side. If you can spot movement 88 degrees to the side you are an average driver.

FIND HOW SMOOTHLY YOU DRIVE by clamping a can of water on one bumper, then driving naturally over a prescribed course. In a trial made by Popular Science, an inch and a half of water was spilled. But this will vary with the shape of the can, riding action of the car, and road surface. Test everyone with the same car and equipment; then compare individual scores with the average. Smooth drivers are usually safe drivers.

How Far Ahead of You Is Your Car?

Where is the front of your car when you are going 20 miles an hour on dry concrete? It's 21 feet ahead of you. It will take that distance for your nervous-muscular system to react to the presence of an obstacle, to depress the brake, and come to a complete halt. See on the chart, based on a speed of 20 m.p.h., how that braking distance shoots up under varying road conditions. On glare ice, with no chains, it is 169 feet ahead! That is why the experts on traffic safety say



that speed in itself is not dangerous. Speed *relative to conditions* creates the danger.

The figures cited are from tests that were conducted by the National Safety Council.

procedure. The methods given are scientific.

DON'T think that because you haven't had an accident you are permanently immune: test yourself and your car periodically, beginning with the tests in this issue of PSM.

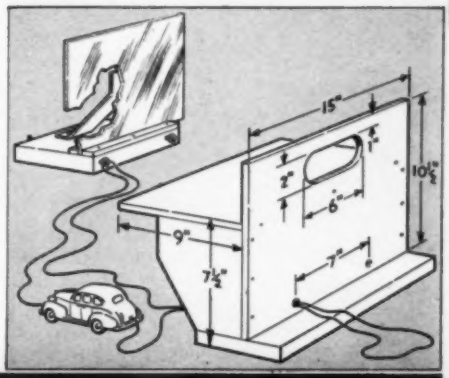
DON'T condone bad driving when you make a mistake yourself, or when you are a passenger in any motor vehicle: yell, "Take it easy!" and you may save a life—maybe yours.

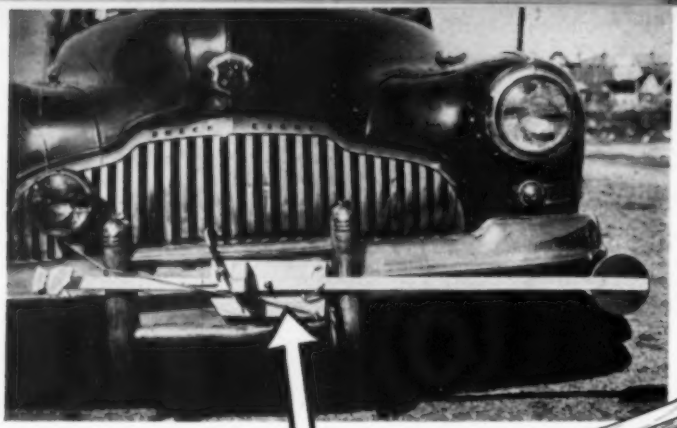
Most of all, talk up good driving around your own dinner table, in your own community: you can help make this most vital of our modern skills the right thing, the smart thing. And talk to the professionals yourself—the truckers who roll the 10-wheelers through your town, the taximen, the cops and the troopers who have to see the crashes, the bus drivers with the lives of the people behind them dependent on sharp eyes and a fast right foot. Ask any pro what he thinks about while he is driving and it's 10 to 1 he'll answer: "About a half a mile ahead."

DRIVING

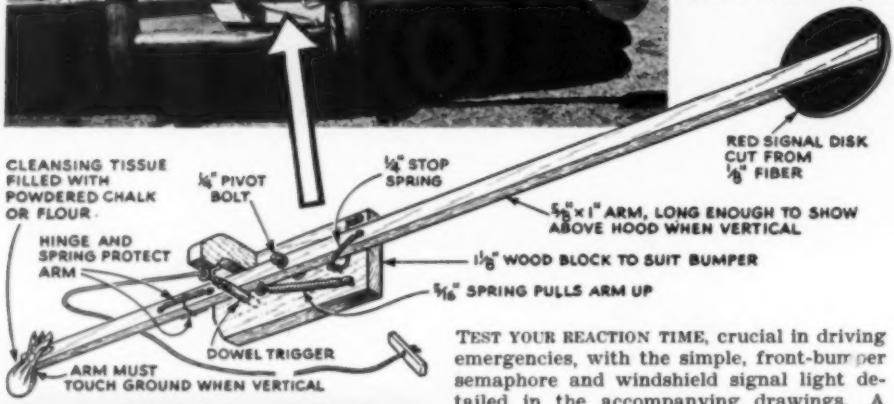
FOUR MORE PAGES OF TESTS

TEST YOUR DEPTH PERCEPTION. It is of vital importance when you are judging speed and passing cars. You can make the device shown here with scrap lumber, a mirror, and toy cars attached to strings. The accompanying drawing clearly shows how it is put together. By looking in the mirror and pulling strings you should be able to line up the two outside cars with the center car in 10 seconds, no matter where the person who is testing you places the center car When you are testing the depth perception of your friends with this apparatus, watch out for smart guys who line up the cars by observing the grain of the table.





Construction of the reaction and brake tester isn't difficult. It consists of a pivoted arm, spring-loaded to swing into a vertical position but prevented from doing so by a dowel. When this trigger is pulled, the semaphore flies up and a flour bag at its bottom marks the spot.



TEST YOUR REACTION TIME, crucial in driving emergencies, with the simple, front-bumper semaphore and windshield signal light detailed in the accompanying drawings. A small bag of flour is fastened to the bottom arm of the semaphore and splotches the pavement when the marker flies up. Your examiner works the semaphore with a cord running out the right front window; holds the light button in his lap.

Drive along a level road at a fixed speed, say 20 m.p.h. When the semaphore pops into sight, jam on the brakes. The distance from the flour mark on the road to where the car has stopped represents your reaction time plus braking time. Test your friends with the same car; since the braking time will be constant, the varying distances will show how individuals varied in their reaction times.

Cup the signal light to the windshield in front of you. When your examiner flashes the light, blow the horn; when he blows a whistle, speed up. Stop only when the semaphore appears. The examiner will watch your arms and legs and score an error when you make the wrong movement.

DO YOU KNOW ENOUGH ABOUT DRIVING?

THIS Driver Information Test is condensed from one prepared by the Office of the Quartermaster General, United States Army. Read each question or statement carefully, then mark the one suggestion that you think is right. Answers are on page 74.

1 Most automobile skids are the result of *(a)* fate and cannot be prevented *(b)* too much snow or ice on road *(c)* overinflated tires *(d)* driving too fast for the road conditions.

2 If a trolley is discharging passengers where there is no safety zone and you drive up from behind the streetcar, you should *(a)* pass to the left *(b)* sound horn and pass slowly on right *(c)* stop back of the nearest door of the trolley car.

3 When you descend a steep hill, the ignition switch should be cut off to increase the braking effect of the engine. *(a)* True *(b)* False.

4 Although automobiles are built today to run at high speeds, it still costs more to drive at 50 m.p.h. than at 35 m.p.h. *(a)* True *(b)* False.

5 If your right wheels get on a rough shoulder of the road, you should first *(a)* turn the steering wheel quickly to get back on the road *(b)* steer straight and slow down gradually *(c)* slam on the brakes *(d)* speed up.

6 When meeting glaring lights at night it is best to *(a)* look straight ahead *(b)* close the eyes for a second *(c)* watch the right shoulder of the road *(d)* look directly at the approaching lights.

7 You are driving on a snow-covered road and have to make a quick stop. The best way is to *(a)* slam on the brakes hard *(b)* roll down the window and signal *(c)* turn off the ignition and apply hand brake *(d)* pump the brake pedal.

8 It requires the same distance to slow down from 60 m.p.h. to 50 as from 40 m.p.h. to 30. *(a)* True *(b)* False.

9 In bringing a vehicle to a complete nonemergency stop from a speed in excess of 30 m.p.h., you should depress the *(a)* clutch and brake pedals at the same time *(b)* clutch pedal first and then the brake pedal *(c)* brake pedal only *(d)* brake pedal first and the clutch pedal later.

10 When driving in a fog at night, you will obtain the best visibility by using *(a)* the upper headlight beam *(b)* the lower, or passing, headlight beam *(c)* the parking lights *(d)* no lights at all.

11 The oil gauge indicates *(a)* the amount of reserve oil *(b)* the pressure at which the oil pump is pumping oil *(c)* how much oil is in the transmission *(d)* the viscosity of the oil in the engine.

12 Generally the safest drivers are those who *(a)* have the best vision *(b)* have the quickest reaction time *(c)* do the most driving *(d)* adjust their driving to conditions they find.

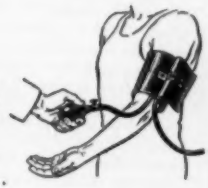
13 Holding your left foot on the clutch pedal while driving is known as "riding the clutch" and results in *(a)* excessive clutch wear *(b)* the rear wheels turning slower *(c)* more control over the car *(d)* easier gear shifting.

14 Which is the most dangerous place to pass? *(a)* just before reaching a hillcrest *(b)* just over a hillcrest *(c)* going downhill 150 feet beyond a hillcrest *(d)* at the bottom of a hill.

15 Who has the right of way if you are approaching an intersection where there is no traffic light or officer and a pedestrian is in the crosswalk? *(a)* you have *(b)* the pedestrian has *(c)* you have if you sound your horn *(d)* neither has.

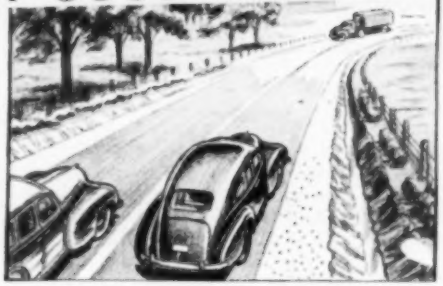
Watch Your Blood Pressure!

RESEARCH at the Center for Safety Education, New York University, shows that many accident-prone drivers are likely to be suffering from markedly low blood pressure. On the other hand, persons with extremely high blood pressure are dangerous drivers. Consult your doctor for advice.



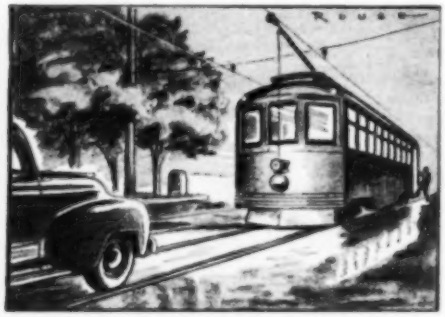
IS YOUR JUDGMENT GOOD ENOUGH?

1 You are driving over a slight rise. A light, wet snow has fallen. As you top the rise you see that a car has skidded and is partially blocking the road at the foot of the hill. You jam on the brake and find yourself sliding down the hill and turning sideways. What would you do to gain control of the car and avoid a collision?



2 You are driving along a two-lane country road that has very little shoulder; a ditch also runs parallel to your side of the road. A car starts to pass you from behind, and at the same moment a truck comes around the curve ahead toward you. The driver of the passing car speeds up to get by. What would you do in these circumstances?

3 You have tried to back into a parking place and find it too small. Your left front fender is in the right of way. A fire engine comes speeding down the street, as traffic approaches from the opposite direction. What do you do?



4 It is a rainy night and you are driving along a street that has a trolley line. As you come up behind a halted streetcar your tires catch in the groove of the tracks and when you brake you slide toward the rear of the trolley. What do you do?

Skill

Driving skill is best tested under actual driving conditions. Studies show that the most revealing single driving test is the U turn. Have someone keep a critical eye on you the next few times you make U turns. NYU's Safety Education Center also has found that another thing distinguishing accident-prone drivers from accident-free drivers of equal experience is the way they overtake and pass cars. Poor drivers frequently fail to signal as they pull out of line to pass, and fail to sound their horns. Check on yourself; if these are your weak points, correct them!

ANSWERS

CARTOON QUIZ ON THIS PAGE: 1. Steer to the right—the direction rear end is slipping—then remove foot from brake until car is straightened out; keep car to left of road, and bring to halt by intermittent pressure on brake. 2. Brake to reduce speed sharply while bringing car to extreme right edge of paved surface. 3. Stay right where you are. The fire-truck driver has already seen you and made allowance for you. Any attempt to pull ahead out of the way may be disastrous. 4. Make as sharp and abrupt a turn to right as possible to bring wheels out of tracks, then turn back to straight ahead and halt by "pumping" brake.

TEST ON PAGE 73: 1. (d); 2. (c); 3. (b); 4. (a); 5 (b); 6. (c); 7. (d); 8. (b); 9. (d); 10. (b); 11. (b); 12. (d); 13. (a); 14. (a); 15. (b).

NAVY *at the* CROSSROADS

By LEON SHLOSS

THE atom-bomb-against-warship tests beginning next month will determine whether sea power is obsolete. "Operation Crossroads," prophetic designation for the experiments during which the world's fourth, fifth, and sixth atom-bomb explosions will take place, may "pipe down" the Navy.

Explosion No. 1, in New Mexico, was an experiment. Nos. 2 and 3, at Hiroshima and Nagasaki, helped end World War II. No. 4 will be set off several hundred feet above 97 ships and a great variety of other equipment in the lagoon and on the Pacific atoll of Bikini. Out of the arching spout of fire, smoke, and water will begin to emerge the shape of the future Navy (see page 82). The blueprints will be clearer after No. 5 has burst on the ocean's surface in July. An underwater test (No. 6), tentatively scheduled for some time next year, may never be held because of the danger of starting a chain reaction impossible to control.

Joint Task Force One, the unique Army-Navy group formed to plan and carry out the tests, could not have chosen a site where less human and economic disruption could be caused than at the elliptical Bikini Atoll.

In the deepest water of the lagoon the largest group of target ships will be anchored in a circular formation, with battleships, cruisers, and carriers at the hub. Over this hub, A-bomb No. 4 will descend by parachute from an Army Air Forces B-29.

Vice-Admiral William H. Blandy, 56-year-old Deputy Chief of Naval Operations (Special Weapons), who commands JTF One, wants to be sure the test is conclusive. That is why the bomb is being exploded over the exact center of the Navy's most powerful warship types. But Blandy also wants to know what the atom bomb will do to all types of vessels at varying ranges. So, other groups will be anchored throughout the 200 square miles of the lagoon. Submarines not only will be anchored on the surface but will be spotted at different subsurface levels to determine the underwater effect, if any, of the aerial burst.

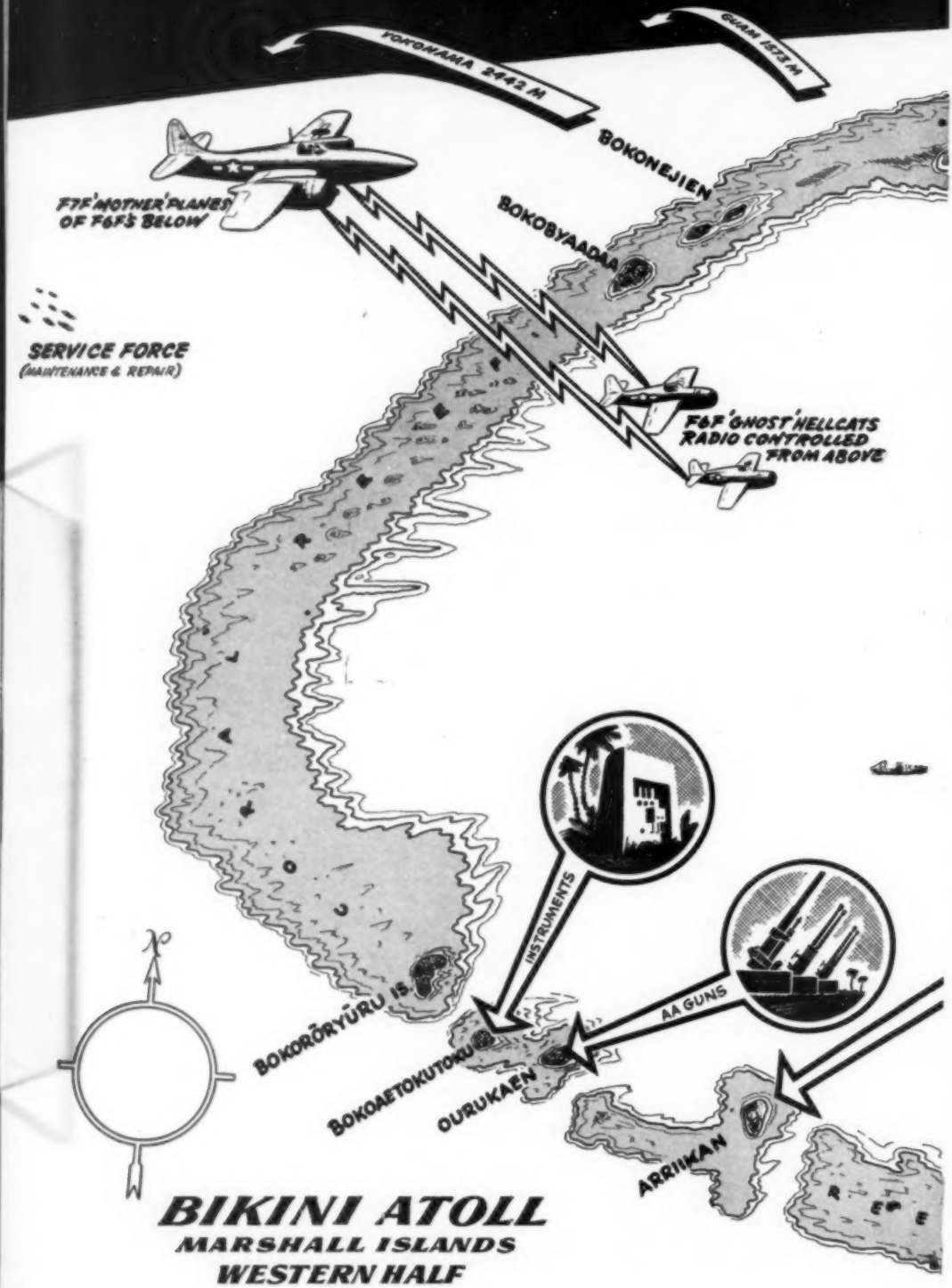
The Army seeks to discover what the bomb will do to its materiel, so the target ships will be loaded with tanks, light artillery, clothing, food stores, etc. Sea stores also will be carried on the various vessels.

Overhead, at the moment of the explosion, will fly Navy Ghost Hellcats, radio-controlled pilotless versions of the famous Grumman fighter, equipped with two sets of recording instruments, to find out what the A-bomb does to aircraft in the area and to gather information on aerial formation, carriage, and dispersion of radioactivity. One set of instruments will be contained in an ejector pack, which will be blown out of the plane by the blast and floated to the water by parachute. Four Army B-17 "drones" will be radio-guided through the billowing atomic-bomb cloud itself, carrying airtight bags that will be opened and then closed by radio while inside the cloud, thus bringing back samples of it—if the planes survive.

In addition to placement of cameras and other instruments aboard ships and in aircraft, they will be utilized on land, mounted atop heavy 100-foot steel towers and shielded in rooms constructed of thick lead sheets. Inside the lead housing the cameras, operated by radio from a distant ship, will photograph through optically flat windows and thence through portholes in the lead housing. The portholes will close automatically after the pictures are taken, to prevent entrance of radioactive waves.

Winds of 500- to 1,000-mile force are expected to cause waves of tidal proportions. Heat up to 100,000,000 degrees Fahrenheit may develop. Leaders of JTF One believe the initial effect against the anchored fleet may be a sledgelike downward blow. This belief is based upon the Japanese bursts, which flattened roofs and floors but left many walls standing. Whether decks will be blown through keels is an oft-repeated question. Also: will the fantastic wind forces capsize the warships? Will the cosmic furnace melt or fuse the steel hulls? Hundreds of pairs of keen, trained eyes will strain from the observation fleet, eight to 10 miles away, to pierce the rolling smokebank for the answers to these and many other questions. Television cameras on Bikini will flash just what is happening in the lagoon to screens aboard this fleet.

An Evaluation Board, composed entirely of civilians to assure impartiality, will render the final verdict on effectiveness of the new weapon against sea power.

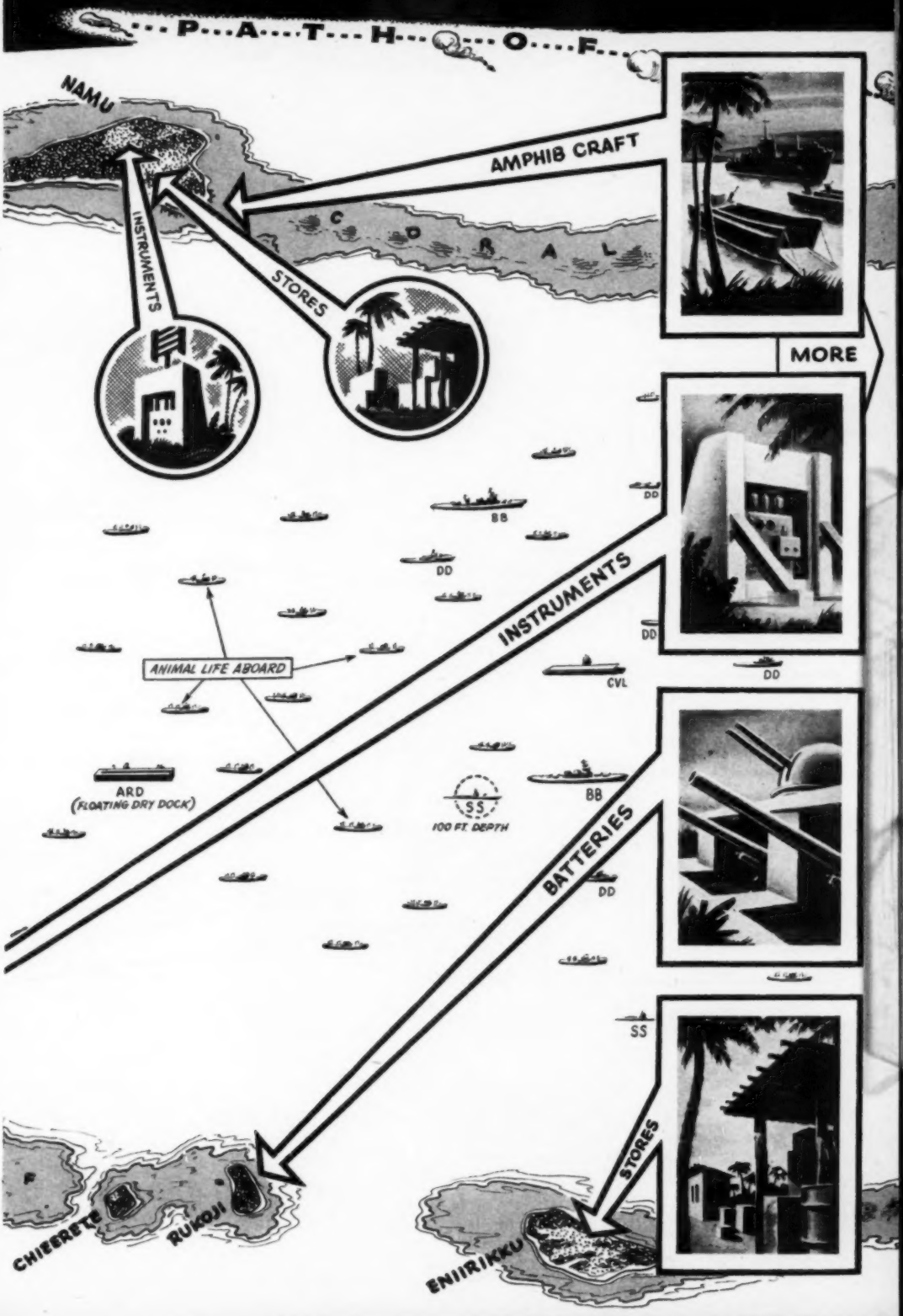


BIKINI ATOLL

MARSHALL ISLANDS

WESTERN HALF

CARTOGRAPHY BY M. I. COHEN
INSERT ILLUS. BY RAY PIOCH


P A T H O F
NAMU
AMPHIB CRAFT
C O R A L
INSTRUMENTS
STORES
MORE
INSTRUMENTS
BATTERIES
STORES
BB
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DD
DD
CVL
BB
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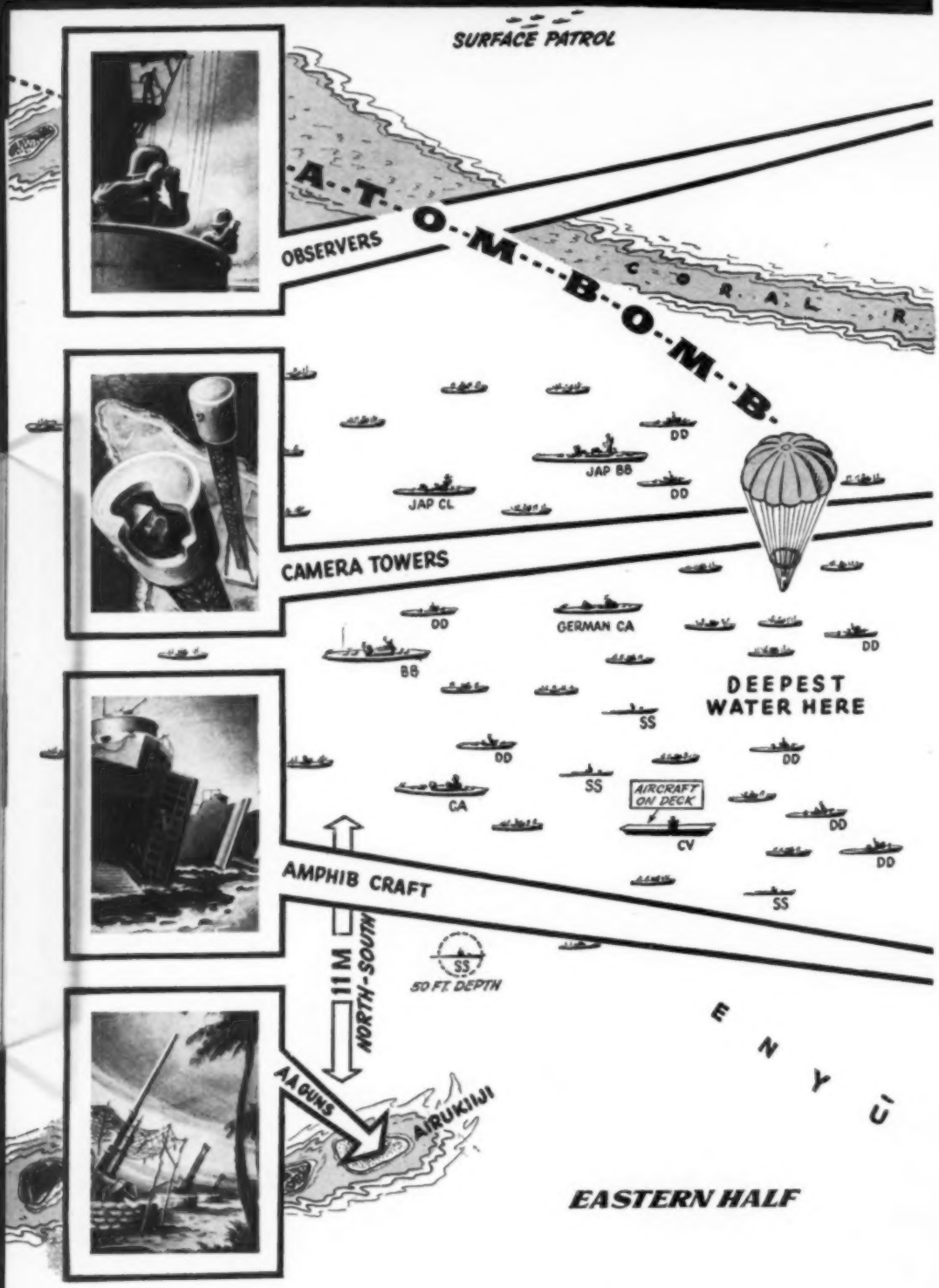
SS
ANIMAL LIFE ABOARD
ARD
(FLOATING DRY DOCK)
SS
100 FT. DEPTH
CHIBERETE
RUKOJI
ENIIRIKKU


SURFACE PATROL
A-T-O-M-B-O-M-B
CORAL R
OBSERVERS
CAMERA TOWERS
AMPHIB CRAFT
AA GUNS
11 M
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AIRUKIIJI
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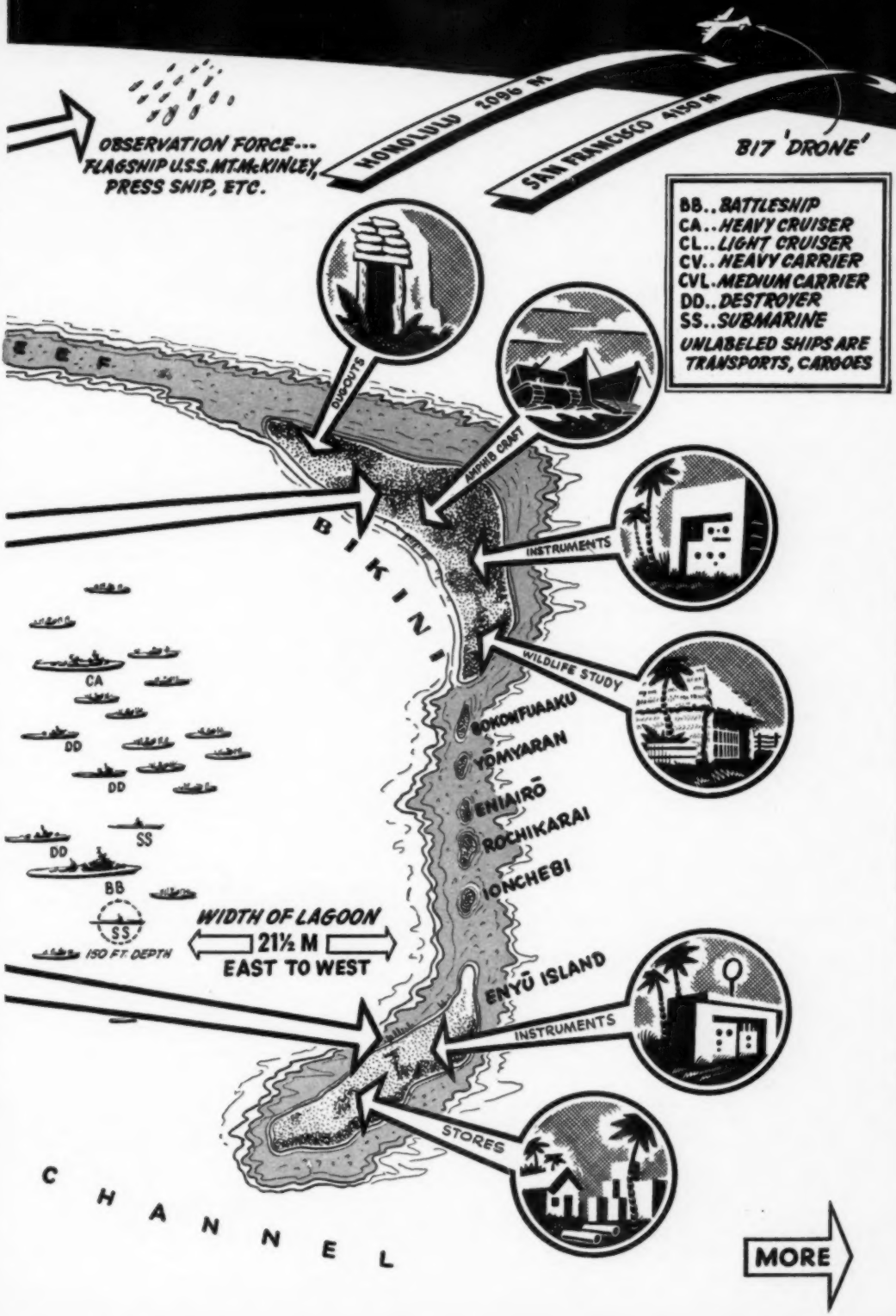
OBSERVATION FORCE---
FLAGSHIP U.S.S. MT. McKINLEY,
PRESS SHIP, ETC.
HONOLULU 2096 M
SAN FRANCISCO 4130 M
B17 'DRONE'
BB..BATTLESHIP
CA..HEAVY CRUISER
CL..LIGHT CRUISER
CV..HEAVY CARRIER
CVL.MEDIUM CARRIER
DD..DESTROYER
SS..SUBMARINE
UNLABELED SHIPS ARE TRANSPORTS, CARGOES
DUKWS
AMPHIB CRAFT
INSTRUMENTS
WILDLIFE STUDY
BIKINI
BOKOWFUAAKU
YŌMYARAN
ENIAIRŌ
ROCHIKARAI
IONCHEBI
ENYŪ ISLAND
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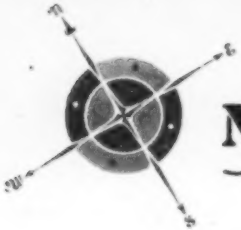


NAVY *plans to go* HIGHER *and* DEEPER

New Planes, Submarines to Be Fleet's Backbone.

IF THE atom bomb, incipient weapon of nuclear science, smashes the Bikini target ships themselves into atoms during "Operation Crossroads," what lies beyond those crossroads for the American Navy?

Many members of the Navy's High Command concede that surface warships are doomed. These officers are already designing the "Navy of the Future." Other high officers believe that at least the battleship, with greatly reinforced armor and bearing new atomic weapons, will continue to exert a dominant influence. Still other naval authorities are convinced that the atom-bomb tests will not be conclusive because the targets are to be immobile.

Consensus is that the Bikini experiment (see pages 77-81) will result in a revolution in naval architecture. Here's why. When an atom bomb is exploded, great compressional waves fly outward. In the air, these waves travel about 1,000 feet a second. In water, they travel five times as fast. Thus, when the underwater bomb blast is set off (third test), the water will transmit the shock upward at 5,000 feet a second. In addition, steel transmits shock waves three times as fast as water. What is going to keep the steel hulls of the target ships from crumbling like eggshells when the steel picks up the compression force already traveling a mile a second and zooms it on through surrounding structure?

Another devastating effect will result from the subsurface blast as the unleashed energy, seeking release, heads upward in the direction of least pressure. The explosion probably will blow a hole in the ocean a mile wide. When the surrounding water rushes in to fill the hole left by the first geyser, it will meet in the center and a second giant waterspout will rise. Circular walls of water will rise farther away as the process is repeated. Ships are bound to be engulfed in mountainous waves. A member of the Navy's aviation command predicts that the explosion would render inoperable the flight decks of carriers and the main decks of other warships within a mile radius.

If then, as indicated, the surface Navy is about to be rendered obsolete, what is to replace it?

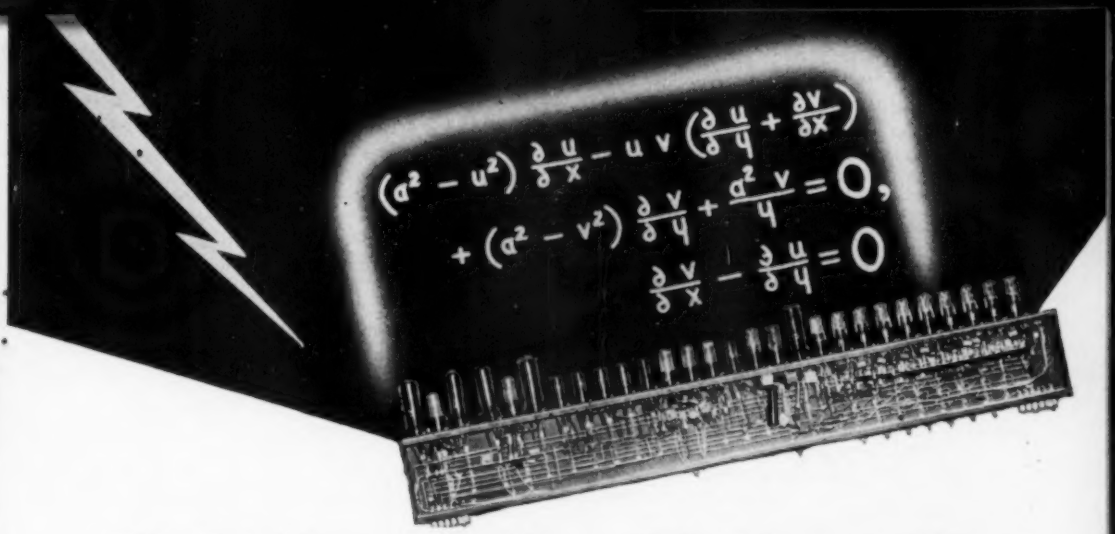
Secretary of the Navy Forrestal says 1,079 ships and 3,731 planes will be ready for instant action, but he is thinking of the immediate future and of whatever policing duties are assigned the American Navy under international agreements. Long-range planning is revolving around the submarine. Vice Admiral Charles A. Lockwood, wartime commander of submarines, claims the submarine can oppose the atom bomb. He indicates that submarines carrying planes that could carry atom bombs and submarines capable of launching guided missiles with atomic warheads are being considered. These submersibles may be powered by atomic energy and travel under water as fast as surface craft.

How the submarine would fare against an underwater A-bomb, the Navy will not discuss, but the zeal with which the "supersub" project is being pursued intimates some defense. Fleet Admiral Chester W. Nimitz is known to favor the submarine as the new offensive warship.

Plans have been drawn for a submersible nearly 800 feet long that would deliver rockets and guided missiles, and at the same time carry sonic-speed aircraft.

Aircraft, piloted and pilotless, will play a focal role in the future Navy. Under development, and in at least one type successfully test-flown, are supersonic craft reaching speeds of 1,500 miles per hour. Guided by radio, radar, and television they will be able to seek out and destroy enemy targets with new munitions. They can do the important pre- and post-attack scouting. Giant stratosphere transports can carry armies of occupation and supplies.

It's a safe bet that as a result of Bikini the structure of navies, which within the last 100 years has been changed by steam, steel, the screw propeller, the long rifle, the torpedo, the mine, the submarine, and the airplane, will be radically revised. And it's just as safe a bet—and fitting—that the submarine and the airplane will be the backbone of the Navy of the Future.



Lightning Strikes Mathematics

EQUATIONS THAT SPELL PROGRESS ARE SOLVED BY ELECTRONICS

By ALLEN ROSE

Dr. J. W. Mauchly

SOME day, travelers may step out of a plane in San Francisco 10 minutes, by local clocks, before they left New York. That day has been brought closer by the work of two brilliant young engineers at the Moore Electrical Engineering School, University of Pennsylvania.

Dr. John W. Mauchly (38) and J. Presper Eckert, Jr. (26) have designed and built, with an assist from Army Ordnance, the world's first all-electronic computer. The speed and scope of this digital wizard will revolutionize methods of modern industrial design. It is expected to put mathematics back into industry as an economical, rapid tool, saving months of figure work and accomplishing part of the presently impossible.

The plane, rocket, or wing, in which a passenger may travel well over 1,000 miles per hour is now just a ghost on a blueprint. Engineers at Republic Aviation Corporation say it is hidden somewhere under a huge mass of highly complicated mathematical equations. The engineers believe that those equations must be completely analyzed before any promises can be made about supersonic speeds. The Eniac (Electronic Numerical Integrater and Computer) has made complete mathematical analysis of that kind feasible for the first time.

Such computations involve the handling of many numbers as large as or larger than 2,156,789,463. With pencil and paper, the average man can multiply that number by 1,987,437,846 and get 4,286,485,004,620,-216,698 in five minutes. He might even be able to turn out 10 such answers in an hour. Working 24 hours a day for 229 years, he might finish 20,000,000 similar multiplications, covering 10,000,000 square feet of paper. He then would have completed only the multiplication involved in solving an equation that engineers say is a "basic" aerodynamic problem. It relates directly to the design of shells. It has never been solved.

This would have been the first problem fed into the Eniac if the war had not ended when it did. The 30-ton numerical monster would have turned out all the answers in 130 hours. No other machine in existence could have done it in less than a year.

The Eniac is 1,000 times faster than its best-known predecessor, the mechanical computer built for the Navy and installed at Harvard by International Business Machines (PSM, Oct. '44, p. 86). Differential analyzers, like the famous machines at MIT and Pennsylvania, widely used during the war, are limited in the kind of problem they can handle. No one has yet found a problem too tough for Eniac. Its accuracy, moreover, is much greater than that of the analyzers, which solve problems by mechanical translation.

Dr. Mauchly first recognized the need for a high-speed computing machine while working with immense quantities of geo-

physical data at the Carnegie Institution in Washington. "Why not use electrons?" he thought. When he joined the Moore School in 1941 he met members of the Ballistic Research Laboratory of Aberdeen Proving Ground. Their problem was the same—how to turn out mile after mile of figures in a practical length of time. Firing and bombing tables were urgently needed to keep up with advances in weapons. In addition, Army Ordnance experts needed a machine that would enable them to explore the mathematics of their field far beyond the point they could then go.

Captain Herman Goldstine, of Ordnance, a mathematician himself, was enthusiastic about Dr. Mauchly's ideas and fast-talked the Army into pushing the project. Dr. Mauchly and Mr. Eckert, a recent Moore School graduate, started work in 1943 and finished in late 1945. They invented several other electronic counting devices on the way. Dr. Mauchly gave one of these, an elementary gadget, to his young son. Its flashing neon lights made a fascinating crossing signal for the youngster's electric train.

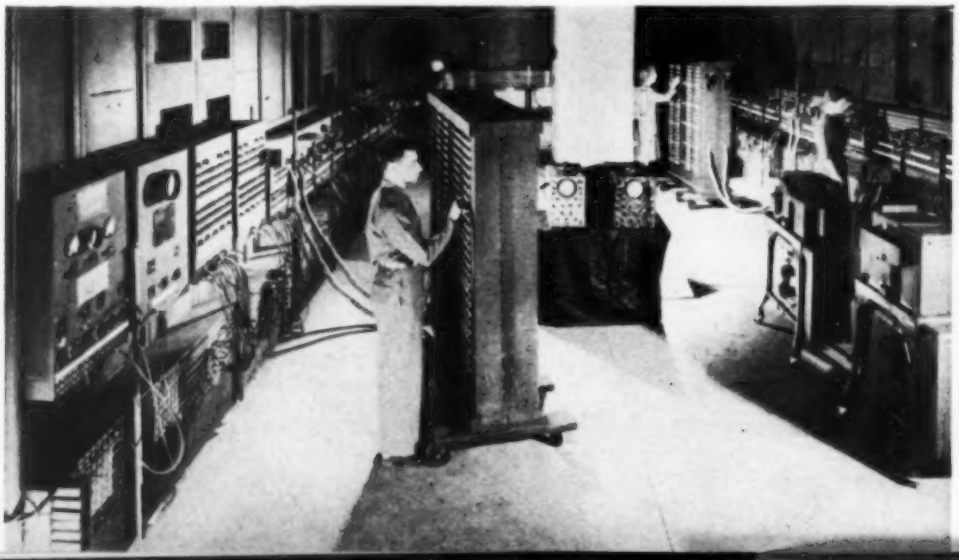
The Eniac is now housed in a 30- by 50-foot room, ventilated to draw off the heat generated by its 18,000 electronic tubes. Entering this room through an inconspicuous door at the end of a hallway in the Moore school, visitors find themselves suddenly hemmed in by dials and cables. Forty panels cover three sides of the room with switchboards.

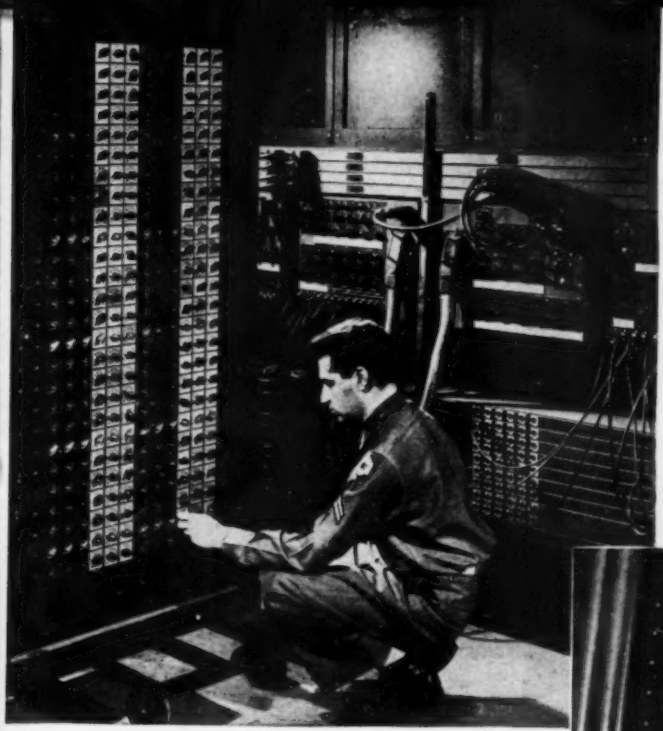
The machine has 20 accumulators, the panels that add, subtract, and "remember." Three function tables of two panels each also contribute to this memory. By means of these panels, entire series of trigonometric functions, for example, may be applied at electronic speed to any numbers in the machine. There is one panel that does the dirty work of division and square root. The other panels contain the initiating unit, where the first button is pushed; "programmers," which police the circuits and permit any variations of the basic operations; and the cycling unit, which sends out 5,000 pulses per second. Above the panels are trays of wires that carry the numbers. Wires in other trays, below, carry the orders. Connected to the Eniac, a part of the complete installation, are two modified punchcard machines that permit the mysterious device to communicate with the outside world.

The Eniac adds two 10-digit numbers faster than a man can write "1/5,000 of a second," the time the machine actually requires to do the addition. The machine will multiply the same numbers in 1/360 of a second, faster than a man can push the button and get over to the instrument that takes out the answer, 15 feet away.

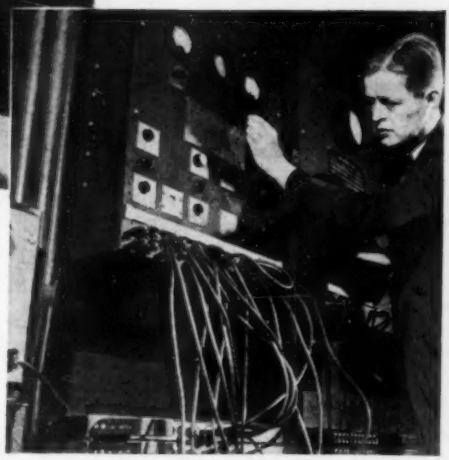
When using the Eniac, a mathematician must set up the equation, because the machine only does what it is told. The mathematician details the entire sequence of what he wants done. He figures out just how each cable will be connected and to what panel. Care must be taken to see that these sequences are properly timed. Instructions can be typed out and posted at the bottom of each panel. Someone else then can set the dials and do the actual connecting. When everything has been checked, the op-

Here is the Eniac in its temporary home at the Moore School. The tall panel on rollers in the left foreground is one of three portable function tables. These tables enable the mathematician to apply complete groups of trigonometric functions to any series in the roomsize electronic computer at great speed.





A maintenance engineer adjusts one of the Eniac's portable function tables. The table here is being used to assist the computer's main mechanism in solving a problem; it is hooked into the two panels at right through bronze-encased cables, seen above the operator's head.



T. K. Sharpless, of the Moore School of Engineering, sets a dial on the Eniac's initiating unit, which contains some of the master controls of the huge, complex mechanism. At his right is the cycling unit, from which "brain" impulses flash out at the rate of 5,000 per second to set the Eniac racing through mathematical problems it would take men years to solve. Mr. Sharpless designed some Eniac equipment.

erator pushes a button in the initiating unit and goes off for a glass of water. The Eniac buzzes, clicks, and the job is done.

The operating pulse is sent out by an oscillator at the rate of 100,000 per second. A counter collects these in groups of 20—the basic impulse. It is this pulse, or one like it, that does the work.

In effect, when two numbers are multiplied in the machine, the impulse travels to the reader and tells it to send a number into the transmitter and then to one of the accumulators. Meanwhile, an order has gone out to the accumulator to accept this number when it arrives, ordering the panel to hold it until it gets another instruction. Another pulse meanwhile picks up the second number and sends it in the same way to a second accumulator. Orders then arrive for each accumulator to send numbers to the high-speed multiplier. This unit has been told to take the two numbers, multiply them, and send the result to the printer. Each panel has incoming and outgoing gates at the top and bottom. These gates are controlled by a series of relays, which determine the time each will be open. Each panel also sends out an impulse when it finishes its job, so the entire machine is self-fed after the chain has been started. Any combination of panels can be used from two to 40. A panel can be withdrawn for repair or testing. But the Eniac operates at such terrific speeds that its working cannot be checked without stopping it, which can be done at any point.

Physically, the Eniac is the most intricate and complex electronic device in the world, with 500,000 soldered connections, 70,000 resistors, 10,000 capacitors. Other machines using the same principles need not be so complicated. Scientists have enough unsolved, important problems to keep a hundred Eniacs busy for the rest of time. But

there is also a great need for simpler high-speed machines that can handle less complex problems.

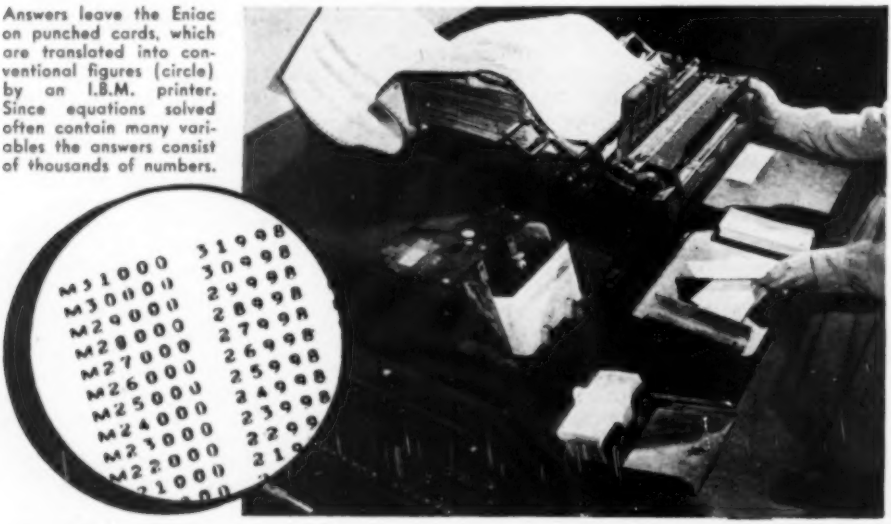
The history of science is studded with immensely valuable theories that lie unused because of the arduous calculations needed to put these theories to practical purposes. Astronomers say that in their field alone there are enough problems to keep at least one Eniac busy. The methods of weather predicting are still largely intuitive because no one has had the time to analyze the figures accumulating for decades.

Industry, of course, cannot stand still during the time lags between theory and applied science. The thermodynamic engineer, for example, knows that his best design lies within certain broad limits that he can determine with comparative ease. But, at this point, the mathematics becomes so arduous that he is unable to get all his answers. The manufacturer of gas turbines doesn't stop work, however, when the mathematics of the cylinder design gets too unwieldy for his engineers to handle. He uses other tools. He starts building models —an expensive and time-consuming process that nonetheless had been cheaper and quicker than any other available method of analysis. He may have to build two thousand models before be clarifies one small point that has been holding him up.

The designer of radio tubes builds rubber models of his electrical fields. He rolls steel balls through these fields to represent the flow of electrons. This may have to be done hundreds of times before some slight change can be made in the tube.

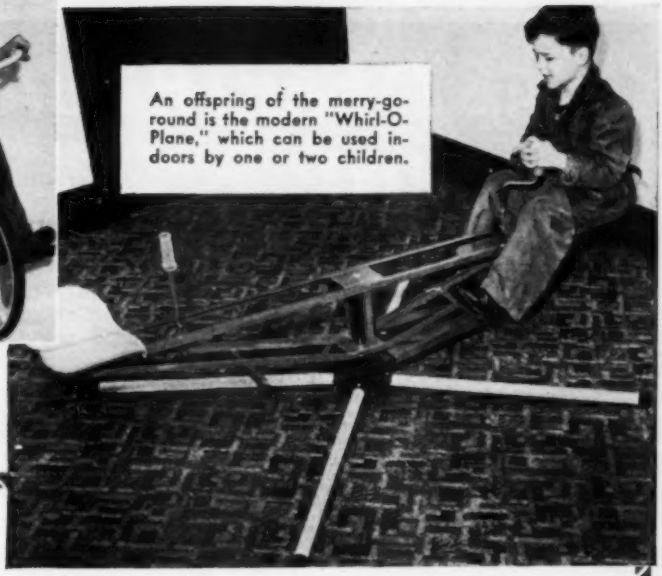
Republic's new high-altitude reconnaissance plane, the Rainbow, is estimated to have cost in the neighborhood of $8,000,000, a quarter of which was engineering cost. This plane, of course, is the latest in a long series. It was the end product of all the tests that have been conducted and all the planes that have been built since the Wright Brothers first flew at Kitty Hawk. No one can estimate how many models have been built in that time, or how much those models cost. The model cost of the airplane industry runs up into the millions. A very high percentage of those models might have been unnecessary if the designers and engineers had been able to use a high-speed computer to work out the mathematics of their complicated patterns. Wind tunnels are expensive to build and operate. Yet, sometimes as much as half the time of these tunnels is devoted to solving problems that could be done by the Eniac, in far less time. And this first Eniac cost about $400,000.

Nothing that man has ever built has been possible without the use of numbers. The cost of handling those figures is a part of the price of every product of modern industry. The Eniac, or even better machines that can now be built with this one as a basis, points the way to a faster and more economical way of handling numbers. It promises cheaper air travel, better radios, wider use of micro-waves, and more efficient motors, for example. With the help of lightning-fast computers to do most of the drudgery on problems that have baffled men for many years, today's equation may be tomorrow's rocket ship.



Answers leave the Eniac on punched cards, which are translated into conventional figures (circle) by an I.B.M. printer. Since equations solved often contain many variables the answers consist of thousands of numbers.

Cast aluminum is used for this tricycle instead of steel tubing to make a lighter play machine.



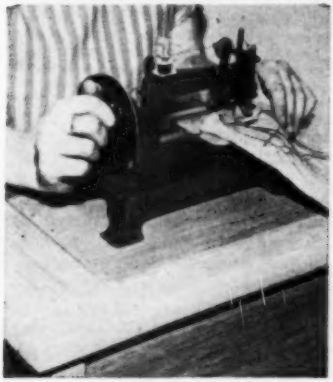
An offspring of the merry-go-round is the modern "Whirl-O-Plane," which can be used indoors by one or two children.

METAL TOYS are here again

PARENTS of toy-age children will welcome back the sturdy metal playthings for which wartime toys were a poor substitute. Boy-proof tricycles, of new design and material, are coming; and improved models of play sewing machines and steam engines. Toy-makers figure on a 30-percent higher output this year to stop the cries of the 5,000,000 more children in the market for the latest thing in bomb-scooters.

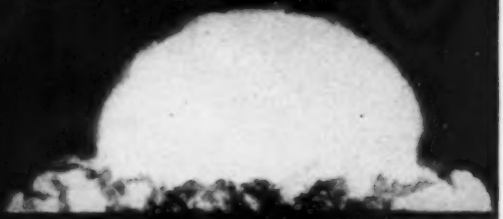
Today the alcohol burner gives way to electricity for firing the toy steam engine.

Future wives can get practical aid in sewing-machine technique with this.



"Pedal Bomb" is what they call this combination.

"BABY EARTHQUAKES" to SPOT STORMS



New waves found in atom blast help map underground, locate oil, check vibration in machinery.

By ALDEN P. ARMAGNAC

EARTHQUAKES of a newly discovered kind can be put to work. They can be given such jobs as warning ships of hurricanes, tracing unwanted vibrations in machinery, locating oil, and mapping underground bedrock for building foundations. Christened "hydrodynamic waves" by their discoverer, Dr. L. Don Leet of Harvard University, these baby earthquakes were recorded for the first time by automatic and hand-operated seismographs of his own design during the full-scale test of the original atomic bomb in New Mexico last July.

A bonanza for scientists in many fields, the biggest man-made explosion offered an earthquake specialist in particular a chance to observe the results of a vertical punch at the earth, under exactly controlled conditions. Dr. Leet had barely four minutes in which to make his records. That was the time it took an 85-foot roll of paper, perforated and sensitized like movie film, to run through the special camera built into his seismograph.

This camera needed no shutter because the paper strip was to be an uninterrupted record of the earthquake waves. The "pen" that wrote this record was a weightless light beam, instead of the customary ponderous arrangement of arms carrying inked pens, or points scraping smoked paper charts. A pair of mirrors tossed this light beam back and forth 11 times before it reached the film, providing an "optical pointer" many times as long as a straight one.

This single feature, more than any other, enabled Dr. Leet to embody the essentials of a seismograph weighing tons in a compact, 65-pound instrument. Resembling a portable phonograph, it could be carried by one man and set up simply by placing it on firm ground, adjusting three leveling screws, and unlocking the moving parts.

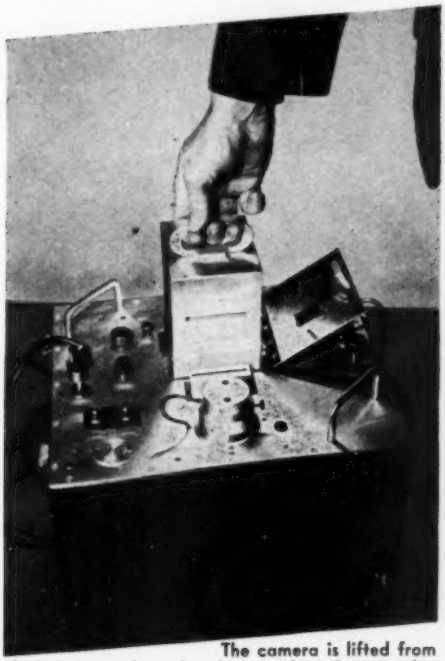
How Dr. L. Don Leet, waiting 10 seconds after atomic-bomb explosion, set his portable seismograph to record resulting tremor.

In the sand of the New Mexico desert, however, Dr. Leet's party first poured a small concrete emplacement several inches deep. Then, a few minutes before the appointed time for the explosion, they gathered about the instrument.

Just as lightning precedes thunder, the flash of the distant atomic explosion warned

Dr. Leet of the earthquake coming toward him. Watching his wrist chronometer, he counted off 10 seconds, about half the expected time of its arrival, and pressed a button that started the film through the camera.

While reporters toyed with sand that had been turned green by the atom-bomb explosion, some time later, Dr. Leet sat in his Cambridge, Mass., office examining his developed film. The microseisms—pronounced "micro-size-ems"—which he had detected and recorded would hardly be noticed by the average person. They would feel underfoot more like the vibration of a passing streetcar than like a convulsion of the earth, but they were definitely tiny earthquakes.

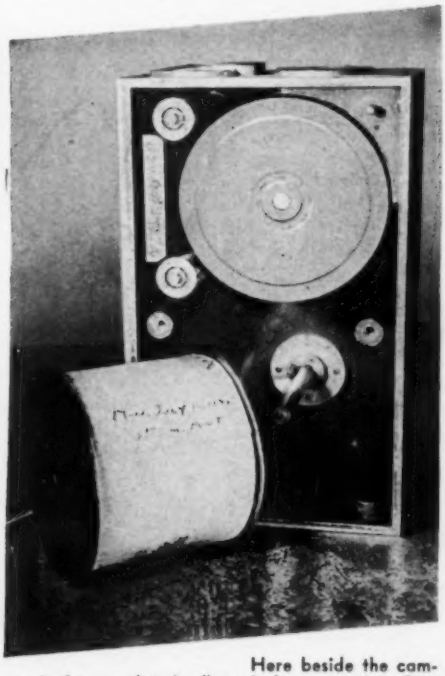


The camera is lifted from the seismograph so that the record on photographic paper may be developed and duplicated for analysis.

Neither Dr. Leet nor the War Department was surprised by this. But Dr. Leet was electrified when he studied his paper films and found that the most prominent waves in the record were of a type never recorded before.

Under the influence of the "hydrodynamic waves," so named for their resemblance to water waves, an elliptical motion is imparted to a free, individual particle of land or sea; it advances at the top of its vertical orbit and recedes at the base. In these respects, these waves resemble the long-known Rayleigh wave, named after its famous British discoverer, except that the earlier type induced motion in exactly the opposite direction. In other words, the sequence of impulses characteristic of the hydrodynamic wave—down, pull, up, push—reverses that of its counterpart. And the atomic-bomb 'quake had a second conspicuous feature. This was a "coupled wave," a type including transverse motion, which had been suspected by the Rev. Daniel Linehan, Weston College seismologist, and confirmed by Dr. Leet in 1939.

Academically, all this was of first-rate interest. But did it have any practical use—



Here beside the camera is the completed roll ready for processing. Certain portions are closely guarded military secrets.

beyond deciding, say, whether a quarry blast or a boy's baseball smashed a kitchen window?

In Dr. Leet's opinion, recently announced by Harvard University on the basis of evidence so far available, hydrodynamic waves and coupled waves probably offer early applications of major importance.

Warning vessels in the path of Atlantic hurricanes and Pacific typhoons (two different names for the same devastating kind of cyclonic storm) in time for the ships to make for safety suggests itself as a prime use for the new earthquake waves. No more elaborate equipment would be needed

than installation of a chain of Leet seismographs along seacoasts, with radio intercommunication between them and with ships at sea. The same rapid fluctuation of air pressure that causes the ominous "pumping" of a ship's barometer, near a storm, probably causes baby earthquakes such as have been observed to radiate from the storm. In contrast to an atomic bomb's range of a few miles, hurricanes emanate microseisms that have been picked up 1,000 miles away.

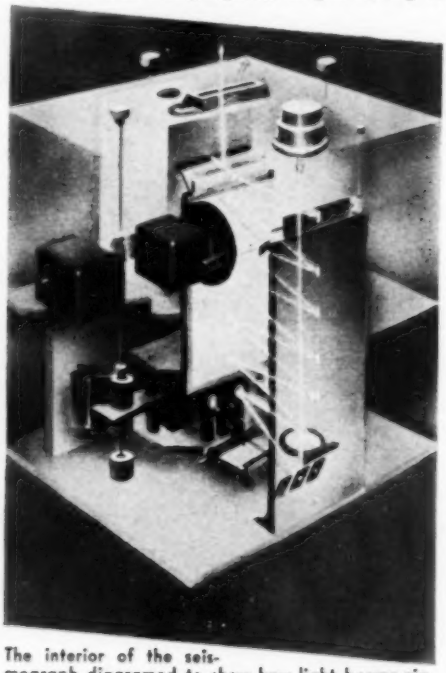
What would be simpler, then, than for two or three shore seismograph stations to take

The scientist reads the story. Dr. Leet discovered that its dominant features are hydrodynamic waves, hitherto unknown to science.

bearings on a hurricane at co-ordinated intervals, a predetermined number of minutes apart? By triangulation, a central station could then locate the hurricane, chart its course, and even determine its speed.

Lest anyone take this lightly, let him recall that during World War II, four U. S. Navy destroyers sank with heavy loss of life, not in combat action but fighting hurricanes and typhoons.

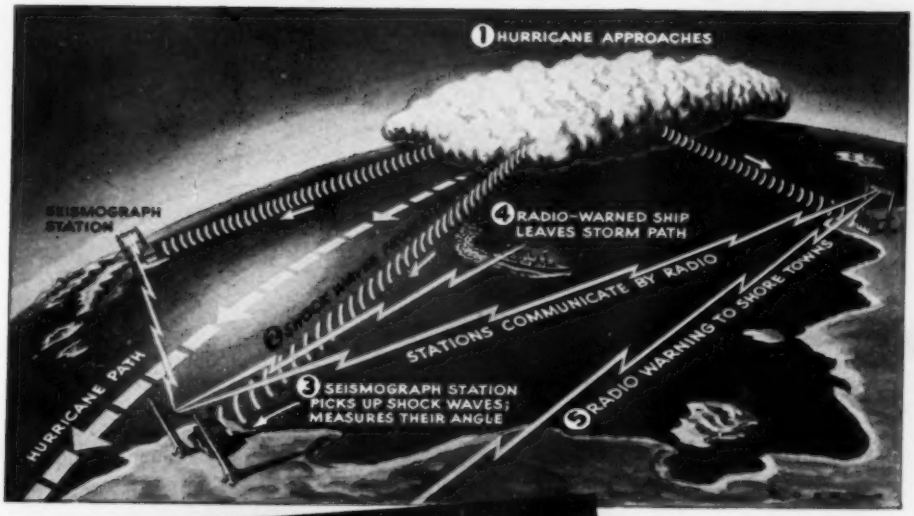
When moving in a horizontal direction, hydrodynamic waves travel at a relatively shallow depth of water or earth, about half a mile to a mile below the surface. Like sound echoes, they bounce off underground formations of rock of contrasting density —a characteristic of microseisms long since put to good use by prospectors for oil. "Wildcatters" who once sank wells with more optimism than success have given way to trained crews with scientific apparatus to explore promising sites. They set off small dynamite blasts at predetermined points on a carefully surveyed map of the district. At other points, receivers like seismographs register when the surface waves arrive, and when the echoes from subterranean formations follow. From the difference in time, the location and depth of "salt domes"—not infallible, but likely signs of oil—are soon charted. For this purpose, the portability of

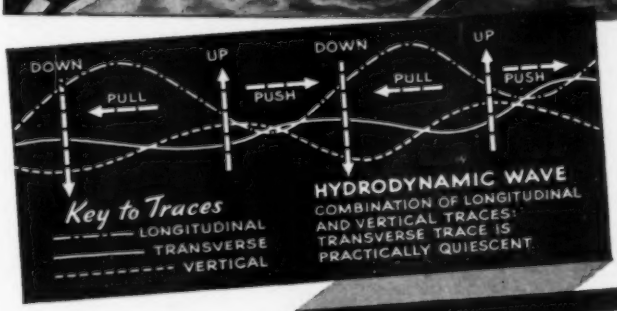


The interior of the seismograph diagramed to show how light beams zigzag to and fro to chart baby-earthquake impulses.

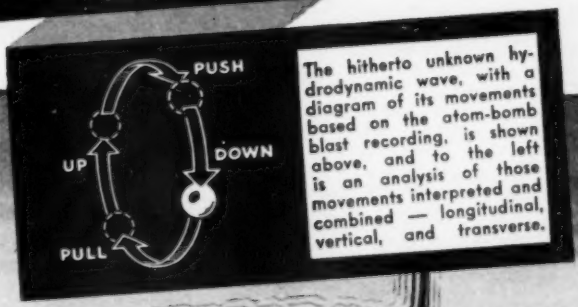
the Leet seismograph especially seems to recommend it. In another suggested application, it would map bedrock to assure firm foundations for the towering spires of tomorrow's buildings.

Finally, in these glistening supercities that we hope to see, we will be spared the bumps, quakes, rattles, and clangs that we have deluded ourselves into considering marks of industry and progress. Whether nerve-racking vibration comes from a pneumatic riveter, a printing press, or a Diesel plant, a Leet seismograph would readily trace it to its source.

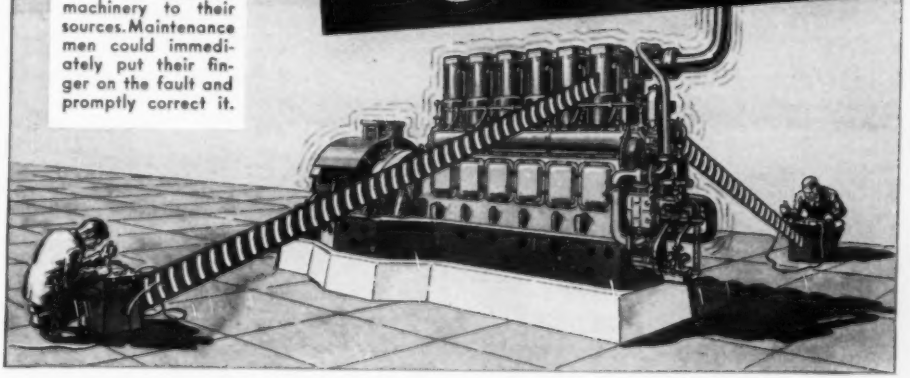




High-speed hurricane warning by the Leet seismograph is diagramed in the above drawing, showing how quakes emanating from hurricanes might be picked up by separate shore stations. Storms' position would be radioed to ships.



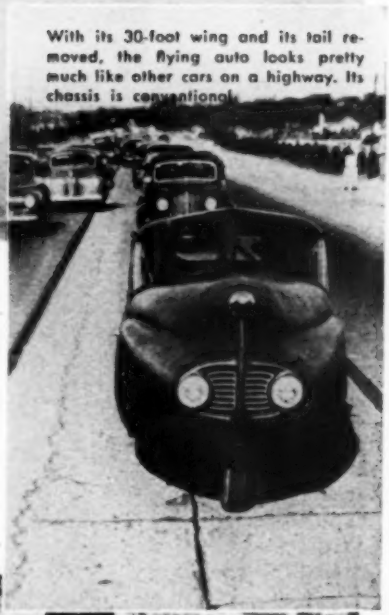
The hitherto unknown hydrodynamic wave, with a diagram of its movements based on the atom-bomb blast recording, is shown above, and to the left is an analysis of those movements interpreted and combined — longitudinal, vertical, and transverse.



With "baby-earthquake" detectors, experts may trace squeaks, thumps, and rattles in industrial machinery to their sources. Maintenance men could immediately put their finger on the fault and promptly correct it.

Ted Hall's original idea in mating an automobile to an airplane was to develop a design that paratroops and commandos could use.

Drive Right Up

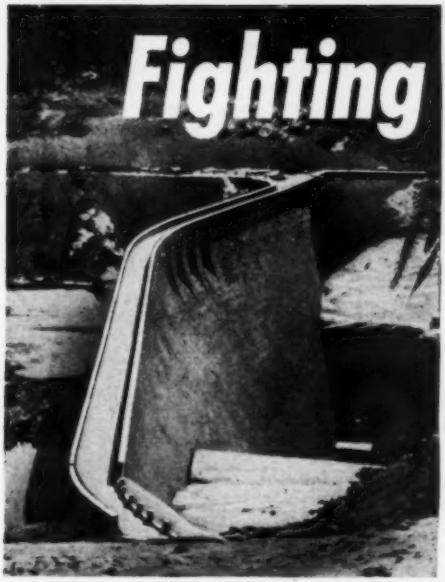


With its 30-foot wing and its tail removed, the flying auto looks pretty much like other cars on a highway. Its chassis is conventional.

A FLYING automobile with a 130-hp. Franklin engine cruises at 110 m.p.h. in the air and travels 60 m.p.h. on the road. Those speeds were set by the first model of a design by Ted Hall, aviation engineer. Portable Products Corp., Garland, Tex., is considering the possibilities of producing it.

The "roadable" plane has detachable propeller, wing, booms, and tail. The forward end of the engine crankshaft turns the prop, while a shaft extends aft from the engine into a conventional automobile transmission and differential. Power goes both to propeller and rear wheels for the take-off.

Hall's three-wheel, "roadable" airplane seats only two, but has ample luggage space in the rear. Rear wheels are on shock struts.



Schluchsee Dam, 950 feet long and 120 feet high, held enough water to wash out our Rhine crossings.

Floods with Models

LESSONS LEARNED ON THE RHINE WILL HELP TAME U. S. RIVERS

By LT. COL. STANLEY W. DZIUBAN

U. S. Army, Corps of Engineers

BECAUSE they had learned how to control rampaging rivers in a laboratory at Vicksburg, Miss., U. S. Army engineers were able to tell where, when and how Allied troops should cross the Rhine. And what they learned in Europe about how to handle millions of gallons of flood waters will help tame the Mississippi, Missouri, Ohio, Connecticut and other American rivers.

The Army acquired this know-how largely with models — hydraulics models — although the efficient flood-prediction system used for years on many of our rivers was an important aid.

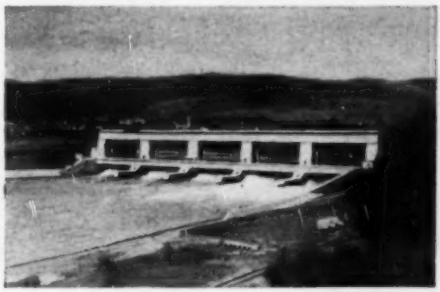
In the Waterways Experimental Station at Vicksburg, the world's largest hydraulics laboratory, Army engineers have built large models of U. S. rivers. On these models they have reproduced various kinds of floods and tried out proposed methods of dealing with them. Impressive advances in flood control and navigation construction work have resulted.

During the anxious winter of 1944-45, French scientists and workmen, supervised by U.S. Army engineers, built a model of the Rhine that incorporated all the engineers had learned at Vicksburg, and more.

As early as the Tunisian campaign, the United Nations had been tipped off to titanic tricks that the Nazis were prepared to play with artificial floods and flood waves. Captured German staff studies showed what could be done by manipulating or destroying hydroelectric and other dams. By opening and closing such dams in proper sequence, sections of certain rivers could first be dried up and then swept by huge flood waves that would destroy boats, ferries, and floating bridges, and thus wipe out our means of supporting any troops who might make a surprise crossing. The captured studies showed, too, that those flood waves could be repeated in cycles and thus thwart efforts to build semipermanent pile bridges.

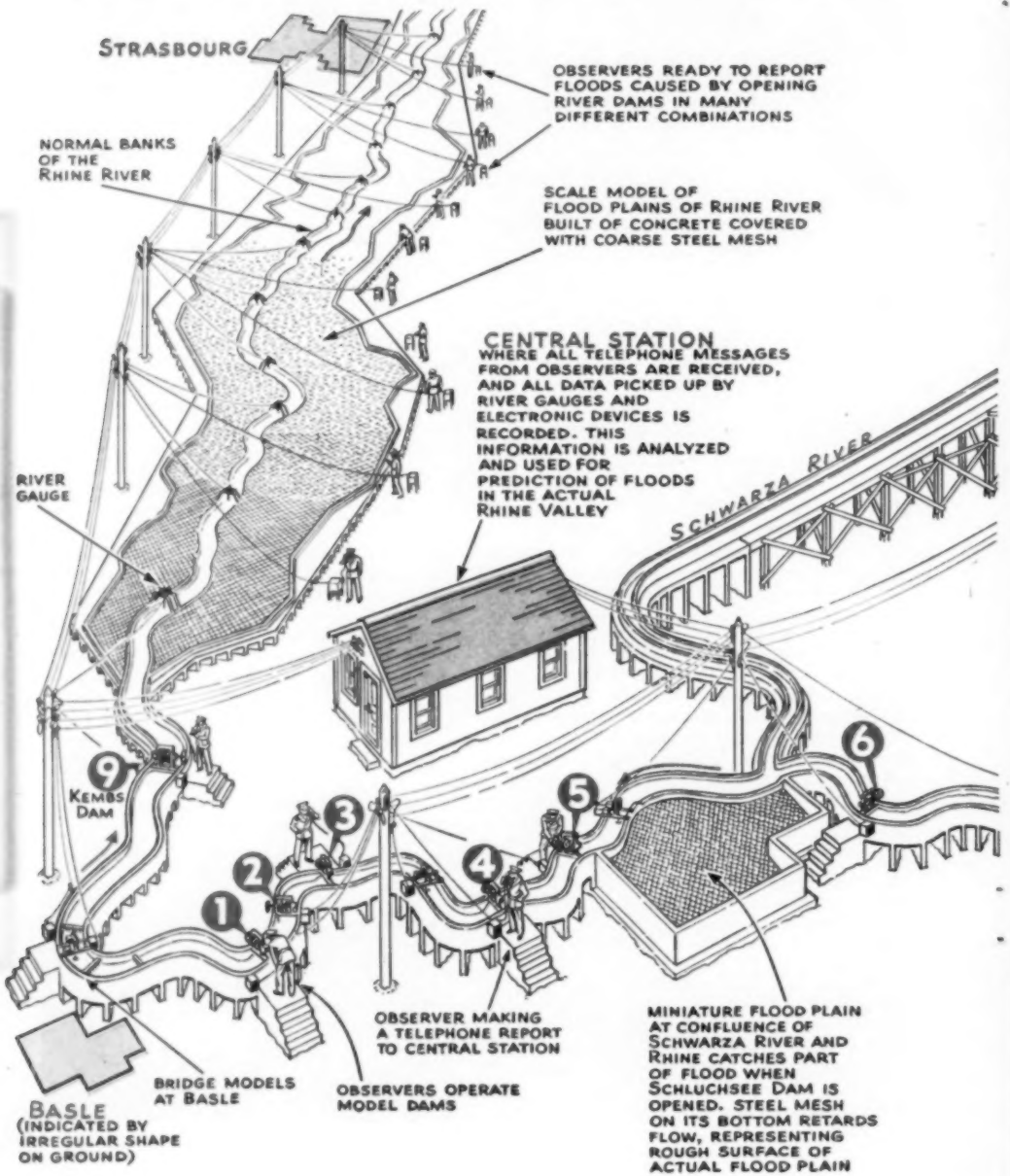
Engineers of the Sixth Army Group saw, in August 1944, that if they tried to force an assault crossing of the Rhine somewhere between Basle, at the Swiss border, and Mannheim or Mainz they would be particularly vulnerable to these artificial floods. They found that there were seven dams along the Rhine from Basle to Lake

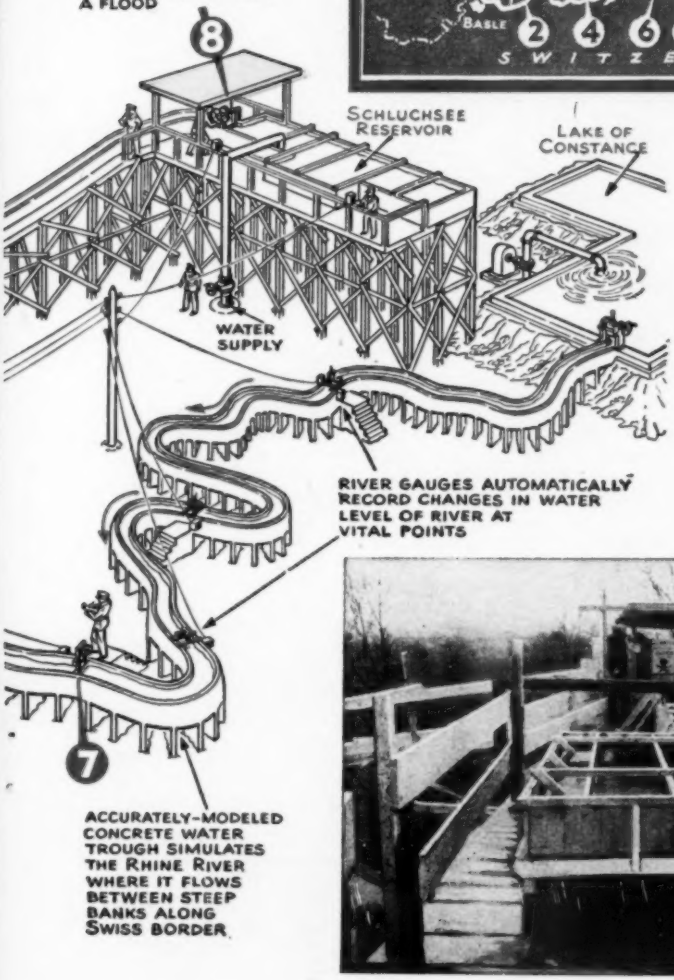
Albruck-Dogern is typical of the seven Rhine dams whose weir gates could produce floods repeatedly.



Constance. These consisted of sliding steel weir gates, which could be raised quickly to release the mighty force of flood waters. But they were owned jointly by the Germans and Swiss and we could not bomb them without violating Swiss neutrality. An eighth dam, located just north of Basle, was fully in German control.

Most dangerous of all was the Schluchsee, holding back a mighty reservoir in the Black Forest. If this concrete gravity dam were demolished it alone would pour into the Rhine as much water as Mohne Dam let loose when it was wrecked by RAF "dam busters." The U. S. engineers knew they had a real problem on their hands. To lick it, they set about first to find out just how these artificial floods might act

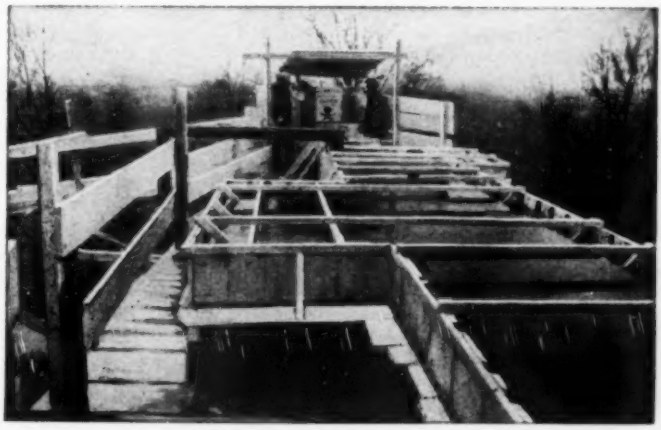




On the elaborate hydraulics models of the Rhine and Schwarza rivers (left), built at Grenoble, Army engineers learned how to simulate the roughness of a river channel, simply yet accurately, and how to duplicate quickly any given flood conditions that might arise naturally or artificially. They used electronic devices to time, observe, and record their data.

Drawing by
STEWART ROUSE

Schluchsee Reservoir (below), as reproduced on hydraulics model.



and what damage they could do, and next, to establish a reliable flood-prediction and warning service.

At Grenoble, they found a manufacturing concern with the largest hydraulics laboratory in France. Despite all kinds of shortages, the firm completed a model in one month that normally could not have been built in less than six months or a year. A 90-mile stretch of the Rhine was reproduced in a model more than 700 feet long. It contained miniature bridges, levees, working models of dams, and other essentials.

Every conceivable combination of flood conditions was tried out in scores of test runs on the big model. Gauges and automatic recording equipment supplied information that was analyzed and translated into graphs. Whenever it was possible, the engineers checked the accuracy of their model experiments with theoretical calculations. They soon were able to predict the size and nature of any flood waves the Nazis might produce, and the time factors involved, at any point in the zone of the Sixth Army Group.

Flood forecasts are based primarily on readings of river and rainfall gauges. Reports are flashed to a central office, where future river levels are predicted, usually only a few days in advance. But the forecasts can be extended by estimating future rainfall from weather reports.

Army engineers set up a flood-prediction and warning service for the Rhine, with headquarters near Paris. As we reached the river at various points, gauges were installed. The AAF provided weather reports. Rainfall was measured in parts of the Rhine Basin under Allied control and estimated in areas still in German hands. Special agents in Switzerland obtained gauge readings of rainfall and the river's level there and were alerted to report quickly any German tampering with the dams along the Swiss border. Their gauge readings were forwarded to the headquarters of the service several times a day by radio, telephone, and teletype. The reports were quickly correlated and accurate predictions and warnings flashed to various Army headquarters.

Fully aware, then, of the effects of potential floods, and protected by an adequate warning system, the Army engineers selected the best sites for assault crossings and bridges. They chose the safest places in the wide, flat Rhine flood plain for assembly areas, dumps, hospitals, and reserve crossing equipment. They arranged with the AAF to destroy the dams along the Swiss border, if the Germans started to tamper with them, in a manner and sequence that would not hurt our ground operations. And they asked for a low level air attack, which put Kembs Dam out of operation.

So accurate were these precautions that in no case did the Rhine interfere with our crossings. Troops were given prompt and steady support, which enabled them to push deep into Germany without pause.

The Germans did attempt to seize complete control of one of the Rhine dams, but were foiled by the Swiss.

American hydraulics engineers now are eagerly studying reports of how the Grenoble model of the Rhine was made and used. Ingenious methods, materials, and equipment went into that model and these will improve our own model experimentation, essential to river improvement work.

The Rhine project has taught us much about the theory of open-channel flow and how to apply this theory. And it will have an important influence on hydraulics engineering in general, affecting instruction, research, design, and practice.

In their flood-control work in the past, our engineers have dealt largely with slowly rising waters, such as heavy rains produce. Now they can apply the lessons of the Rhine to the control of another kind of flood, the steep, devastating rush of water from dams that fail or are blown up. Another war probably would begin with a crippling attack on our industrial potential. This attack doubtless would include hydroelectric and other dams among its objects.

The Rhine project also has taught us how to use artificial floods for defense.

ABOUT THE PAPER In Popular Science Monthly

Like every big publication, *Popular Science Monthly* has been hard hit by the paper shortage. Paper, although printed by the page, is bought by the ton. And to get the tonnage we are forced to take a quality of paper way below our standard. We don't like to do this. We don't like to see illustrations on which photographers and artists, engravers and printers have lavished so much skill come out on the page looking like soft coal on a tablecloth. But we would rather risk poor paper than cut down the number of copies of your magazine—or, worse—cut down the number of editorial pages, which for years has run the same in every issue the year round. As soon as possible PSM will restore the fine, white paper that helped make it such a well-printed, easy-to-read magazine in the past.

The Editors

Your Pin-Up

LOCKHEED P2V NEPTUNE. The Navy's new land-based patrol and search bomber is the first such plane designed and built to keep peace in the sky. Comparable in size and carrying capacity to a B-17, it can range 3,500 miles with four tons of bombs, fight instantly if necessary. It is powered by two Wright 2,300-hp. engines, goes more than 300 m.p.h., has a ton of radio and radar apparatus, requires a crew of seven.

I'D LIKE TO SEE THEM MAKE...

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? Popular Science Monthly will pay five dollars for every such suggestion published.

Puncture-alarm for automobile tires. Tubes would be designed so that a leak would cause a whistle to blow. Mrs. A. G. Hellstern, Hinsdale, Mont., originator of the idea, thinks such a device would guard against accidents.

Fire-hose reel equipment for small houses or apartments. Daniel Gordon, New York City, says it should fit under the bathroom or kitchen sink. A quick faucet connection could be made and the hose unrolled.

Bigger Honorable Discharge buttons for ex-GIs. Kenneth E. Friend, Greensburg, Ind., suggests two advantages: nearsighted civilians would recognize the design more quickly; lost buttons would be easier to find.

Decorative phone that will allow free use of hands. Harriet Inglesby, Holland, Ohio, believes it would be an improvement on the one described in PSM, Oct. '45, p. 96.

Applause transmitter as an attachment to home radio sets. Thus listeners to broadcast programs of all kinds would be able to show their appreciation to the artists or sponsors in the studio. A dial on the individual radio could be turned to indicate the degree of the listener's interest. This could be made to register on a wall chart or scale at the studio, or it might be translated into actual applause that could be heard. The idea was submitted by Lt. Stanley F. Burk, Eskridge, Kan.

OIL PAINTINGS

Famous Artists Portray Petroleum Industry

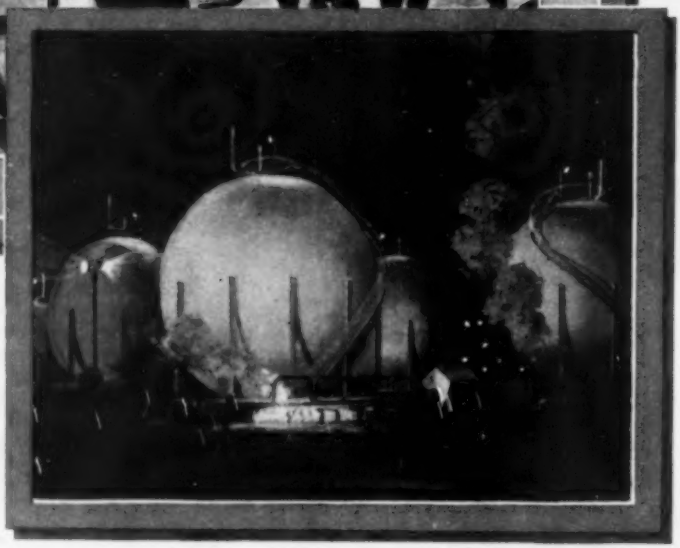
ARTIST ADOLF DEHN depicts man's conquest of nature at a Venezuelan oil field. Some wells stand in water up to 100 feet deep.

NO COMMUNIQUES were issued on the effort of the petroleum industry that boosted production 38 percent to provide three fourths of United Nations oil in World War II, but prominent American artists have captured the drama in oil paintings.

Controverting Napoleon, General Patton said: "To hell with rations. Give me gas." The petroleum industry did—5,250,000 barrels a day. A priceless contribution was 600,000 barrels of aviation gas daily for the air offensive that stopped Hitler's own gas supply.

Even more remarkable than expansion of production were the technological miracles worked. The industry discovered or increased output of such invaluable war materials as gel gas, toluene, camouflage smoke, noninflammable gas, anticorrosives, insecticide bases, all-temperature lubricants, and butadiene and Butyl.

Popular Science Monthly on this and the following two pages presents a representative group of the paintings. The Standard Oil Co. (N. J.) sponsored the project.



IN ARCTIC, Georges Schreiber captures thrill of a well kicking off in a bright pyrotechnic display.

ERNEST FIENE has symbolized the weird and unearthly appearance of the huge spherical storage tanks used for butadiene at Baton Rouge, La.

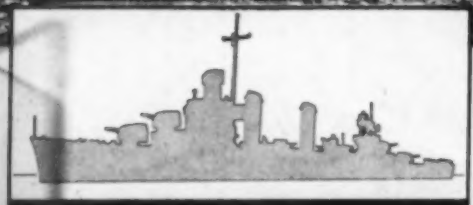
FREDERIC TAUBES caught the fire of the welding rod, dripping molten in the heat and glare of the electric spark, as a welder joined sections of the "Big Inch." This line is 1,252 miles long.

BIG GATE VALVES at ocean terminals of pipe lines (right) made realistic on canvas by Taubes. Some oil gets 1,500-mile pipe-line journey; various kinds can be pumped through in successive batches.

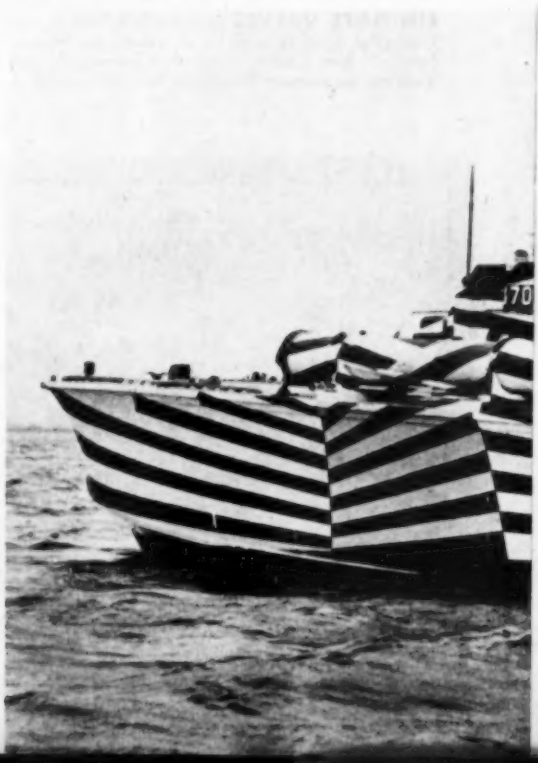
ADOLF DEHN had a jungle setting for this portrait of the pump station at Quiriquire, Venezuela. Roads are carved out between wells, and vegetation must be cut back constantly to keep it from overrunning all cleared space in the area.

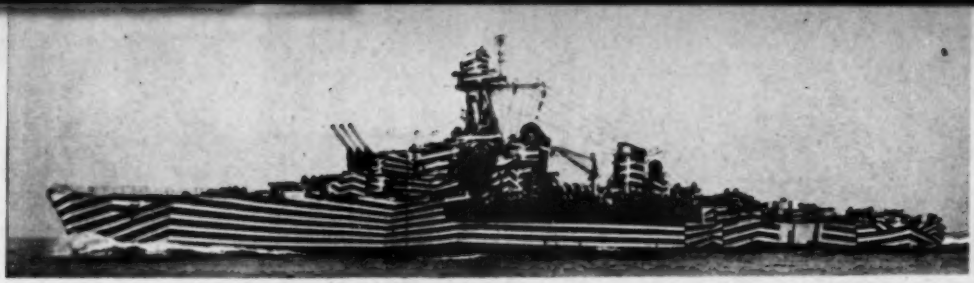
The bewildering confusion of stripes covering the minesweeper in the foreground stresses the effectiveness of the Adaptor System, the scientific method of camouflage developed by Lt. Comdr. George C. Evans. Pattern causes no eyestrain among crew.

How Navy's



Based on established and reliable optical laws, the Navy's World War II camouflage used black and white painted patterns on vessels, producing startling visual deception that was confounding even at a 50-foot range. Strongly contrasted stripes in the designs made accurate observation virtually impossible. False shadows created most deceiving illusions of shape. Sterns were "shortened," gear was "hidden," and entire ships were "heeled" through the scientific use of paint. The ineffective battleship gray and Dazzle System of camouflage (left) were rendered obsolete.

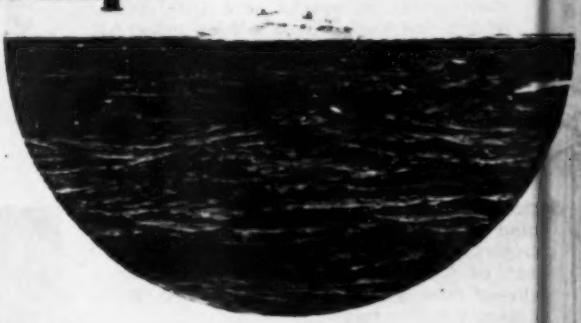




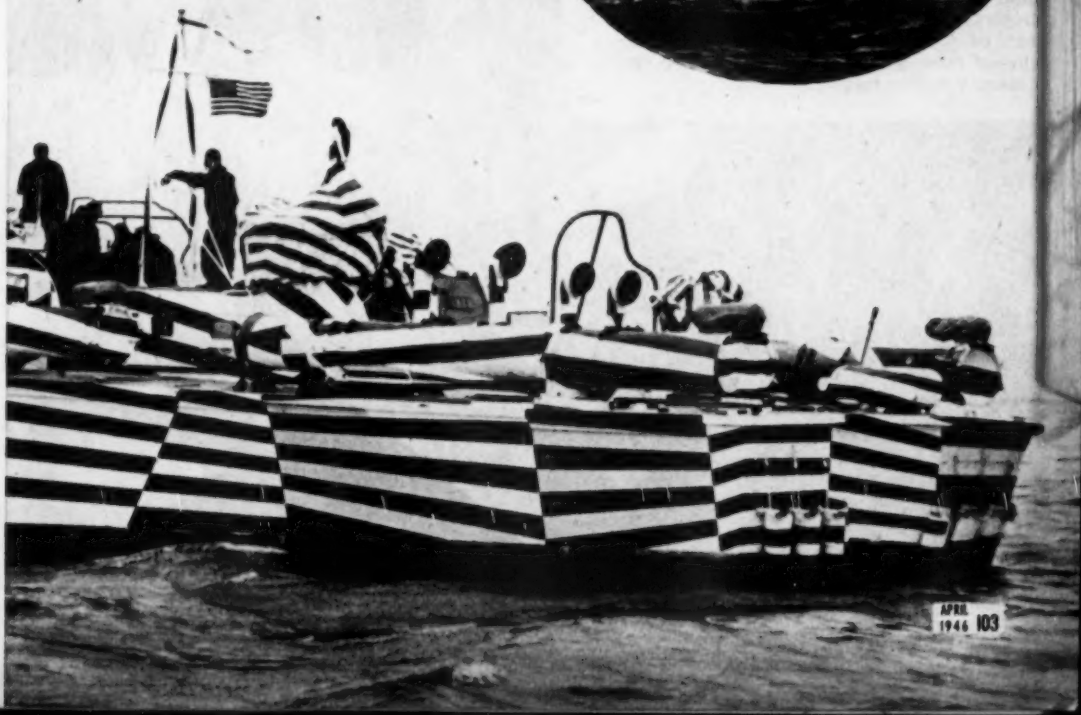
The French cruiser *Gloire* was the first major vessel to get the Adaptor pattern. The long reach of her forecastle has been "cut back" to make her look more like a destroyer, her bow is bent hard to starboard, and her stern is convincingly broken up. At dawn or dusk or in fog the illusion and deception are greatly heightened. Even in moonlight the stripes create bizarre, unpredictable distortions.

Viewed beyond the range at which the stripes visually blend, a ship all but disappears (right). She becomes even lighter as she draws away, a desirable effect against a light-sky background.

New Tricks Concealed Ships



Distorted almost beyond belief by grotesque and eyestraining camouflage, this PT looks as if it had been decorated by an insane awning-maker. Cmdr. John E. Bulkeley had several squadrons so disguised. Some PTs had light-green and black stripes for concealment in tropic waters.



Short-Hop Helicopter

ROTORCYCLE is what the AAF dubbed this Firestone G. & A. helicopter because it was first built to act as a substitute for the motorcycle. It weighs only 1,800 pounds with a full load. Speed is over 100 m.p.h., estimated ceiling above 10,000 feet, and range about 250 miles or three hours. It has less "stick shake" than most helicopters.

Fog Shields Fireman

HIGH-PRESSURE fog puts out this airplane fire in 30 seconds as fireman advances behind a vertical fan spray. The millions of droplets have a heat absorption 35 times that of water from a fire hose. Power take-off from a truck engine maintains the necessary high pressure.

Frances Langford, one of the judges in PSM's handicraft contest, visiting the Birmingham General Hospital, Van Nuys, Calif., offers a bit of encouragement to Pfc. Richard Bikowski, who is working on a band saw.

The stage, screen, and radio star dons a work apron (below) to lend a hand to Pvt. Fred W. Kesler. The wounded Pacific veteran is sanding and polishing a project in plastics.

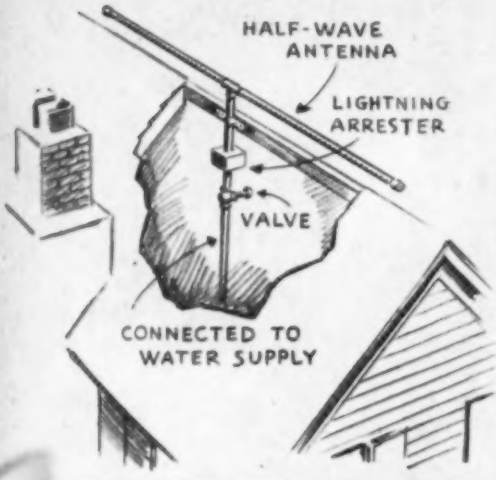
At the clay-work bench, Cpl. Charles A. Brodwolf and Lt. David Jorgenson make room for a willing hand, and Miss Langford tests her skill at modeling.

Judging Begins in GI Craftwork Contest

THE deadline for entries in *Popular Science Monthly's* $3,300 GI Handicraft Contest has passed, and the board of judges has started its work. Only entries postmarked prior to 6 p.m., Monday, April 1, can now be accepted.

In addition to Frances Langford, featured above, the judges include Brig. Gen. Georges F. Doriot, Army Service Forces; Maj. Nathaniel Saltonstall, Chief of the Handicraft Branch of ASF; Rear Adm. Harold B. Miller, Director of Navy Public Relations; Maj. Walter W. Hitesman, Jr., and Sgt. Merle D. Miller, service publication editors, and Mrs. Cass Canfield, noted sculptress.

NEW IDEAS



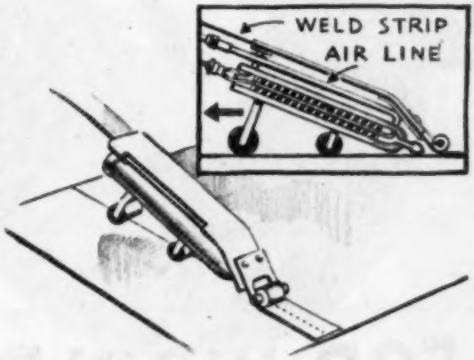
A TELEVISION ANTENNA that can be used also as a sprinkler for cooling a building in hot weather and for fire and lightning prevention has been patented by Edward J. Cowan, of Springdale, Conn. The antenna, made of one-inch brass or copper tubing, has tiny holes on either side through which water can be sprayed. A pipe extending into the building connects to the water supply. The inventor claims that water in the antenna tubing improves the reception of radio waves when the air is dry. It can be placed on new buildings without marring the architectural design.

TWO TROUBLES of smokers would be eliminated by these packaging ideas. Inventor Harold Warp, of Chicago, would have a pack of cigarettes wrapped in a continuous strip of matches so that the smoker would always have a light handy. A striking surface would be provided on any side of the package except the top. The match-stems would be part of the wrapper. Matthew L. Kus, of Carthage, N. Y., solves the ash- and stub-disposal problem. His metal cigarette case (right) has a "sliding ash tray" bottom.

JET STEERING for ships and other watercraft, designed to increase a vessel's maneuverability, is the idea of Morris Katcher and Stanley W. Walker, of New York City. Conduits from intake openings near the bow run to paired discharge openings toward the stern. If the rate of flow of the water coming in remains equal on both sides, the vessel's course is unchanged. But if one or the other of the incoming streams is wholly or partly choked, the opposite one pushes the vessel's stern sideways, causing a change of course. This forward steering means may be synchronized with the conventional rudder in the rear to enable the boat to turn through a shorter radius than if only the rudder were used, or it may be operated independently. The two steering devices also can be used to give the boat a lateral motion.

FROM THE INVENTORS

EVERYTHING BUT TALENT is provided for the musician who uses this combination seat and music stand that Margaret E. Shick, of McFarland, Calif., has invented. The player can adjust the stand both horizontally and vertically, raise or lower the swivel seat, and even rest his feet on the base of the stand, if the orchestra conductor doesn't object to his playing in that informal position. A music rack, built to accommodate both large and half-size sheets in separate compartments, is attached to the left side of the seat, where it is handy. The combination seat and music stand is portable but rests firmly on the floor.



A BLAST OF HOT AIR from this torch, which has been devised by William M. Phillips, Jr., of Detroit, welds a seam or joint in thermoplastic materials. Behind the nozzle that directs the jet of hot air is a roller that smooths the job down. Air is brought to the proper temperature by being passed through a long coil of electrically heated nickel-chrome wire. Rights in the patent are owned by Udylite Corp., Detroit.

POTATO CUTTER. John S. Garner, of Darlington, S. C., has designed a kitchen utensil (right) which, when used sideways, does a prosaic job of potato paring, but which, when drawn endways along a spud, cuts it into long strips suitable for frying and serving as "shoestring" potatoes.

ROPES THAT GLOW IN THE DARK are proposed by Richard F. Warren, Jr., of Stratford, Conn., as a means of indicating the line of a highway fence, or warning of excavations, or locating a towline. Mr. Warren thinks the rope should be made of a mixture of plastic and luminous materials and that it should have a coating of tough, flexible, elastic, and translucent plastic to protect the luminous surface from moisture and abrasion. He also suggests the use of luminous materials that would reflect ultraviolet and infra-red light.

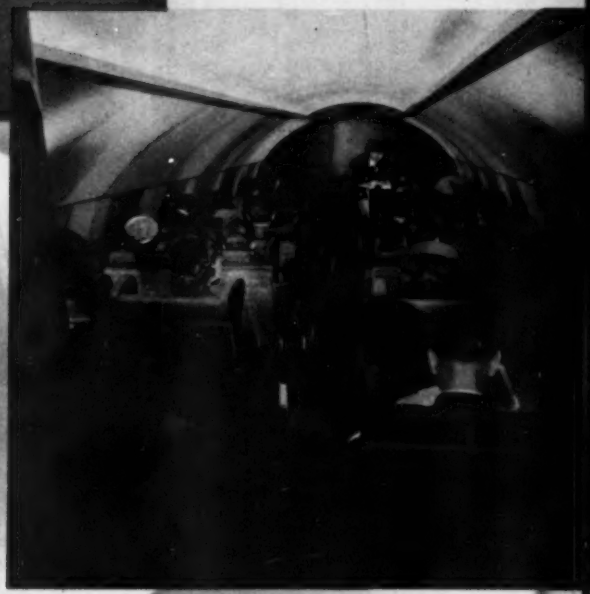
SUPERLINERS FOR WORLD

NEW commercial transport planes, shrinking the United States to 1/200 the size of a century ago in terms of time, are incorporating a brand-new concept of comfort for the passenger. When airliners began operations in the late 1920s, the mechanics of operation were a primary consideration with designer and air-carrier companies. Today cushion-rubber chairs, modernistic lounges, and temperature controls are deemed as important as the navigational devices up front. To those are added speed; transcontinental flight in the Lockheed Constellation, for instance, is a matter of 10 hours, and crossing the Atlantic Ocean between Washington, D. C., and

Double-decked Boeing Stratocruiser has made a record of slightly over six hours from Seattle to Washington, D. C. This comfortably upholstered airliner will carry up to 114 passengers or 39,000 pounds of cargo at speeds well over 300 m.p.h. Cabin is pressurized to the atmospheric equivalent of a 6,000-foot level.

Up to 70 passengers will be carried by day in the Douglas DC-6 (left), while at night the capacity will be 26. Speed and comfort are stressed.

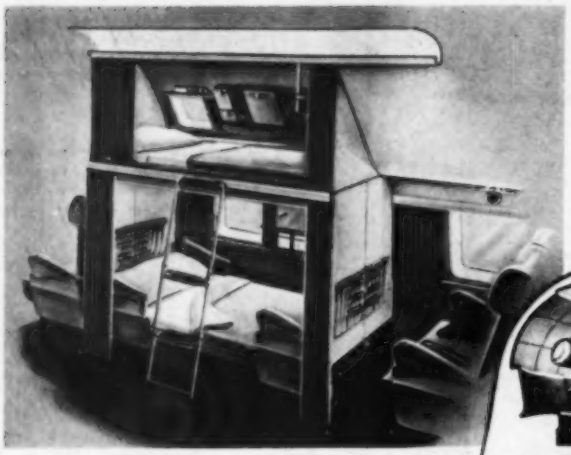
In Convair's Model 110 (below), Henry Dreyfuss has made good use of indirect lighting, polaroid windows, reclining chairs, in interior design.



First postwar luxury air transport to enter service, the Constellation plies between coasts in 10 hours. Passengers getting aboard at New York after the theater reach Los Angeles for a late breakfast.

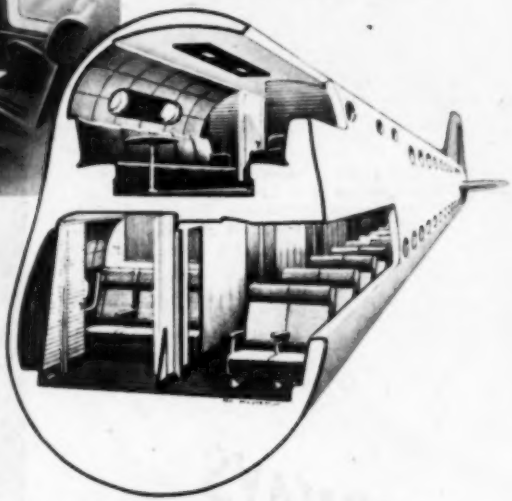
SKYWAYS

Here's the biggest airliner of the lot—Consolidated Vultee's Model 37. Weighing 320,000 pounds, it will be nearly twice as heavy as any land plane yet flown. Six gas-turbine engines will drive the giant.



Each berth of the DC-6 has an outside window. Lowers are 76 inches long, uppers 78 inches, both about 40 inches wide. Bedding and end panels are stored in upper berth.

A cross section of proposed Pan American Clipper, showing the interior of the 204-passenger transport. Upper deck has lounge and rest rooms, lower has staterooms.



Paris, France, takes less than 13 hours. Designers and engineers are preparing other titans to speed the new era of air travel—Douglas' DC-6, the huge Stratocruiser by Boeing, and the gigantic Model 37, by Consolidated Vultee. Soon a passenger may breakfast in London, enjoy a late lunch in New York, and go to bed that evening in Los Angeles.

Just what do these new giants offer?

Constellations carry 57 passengers more than twice as fast as the familiar veteran, the 180-mile-an-hour DC-3. The fuselage in cross section is a perfect circle. Two superchargers pour fresh air into the cabin to hold pressure at a simulated level of not more than 8,000 feet, and heating and refrigeration control the temperature. Circular windows enable passengers to enjoy the unfolding view. More than 100 Constellations are being rushed to completion.

The greater space and comfort provided for Stratocruiser pilots inspired Ernest Norling, Boeing designer, to draw this conception of a flier's dream.

When the DC-6 makes its appearance, it will be 80 inches longer than the DC-4 and will cruise at about 275 m.p.h. Passengers will enter this plane through a door aft of the wings. They will relax in cushion-rubber chairs, and stewardesses will serve meals from buffets near the door.

The two decks of the Stratocruiser have been created by building one fuselage above the other. The bottom section is as wide as the Army's Superfortress. The upper is slightly larger.

Consolidated Vultee's Model 37, developing 30,000 horsepower, will have a cruising speed of 342 m.p.h. This monster will be nearly twice as heavy as any land plane yet flown. On nonstop flights up to 4,200 miles, 204 passengers will enjoy the comfort of four cabins on two decks.

These planes use plenty of gas. At takeoff, the Model 37's six big engines will consume fuel faster than you could bail it out of a barrel with a 10-quart pail, but they develop more power than 360 Ford V-8 engines. The electrical system would supply a town of 5,000.

NEW TOOLS

Portable Saw-Gun Has Streamlined Housing

A TUBULAR, ribbed handgrip features the improved, streamlined housing of the Saw-Gun, a portable power saw and file that is also equipped with a pistol-grip, detachable handle. An ordinary hack-saw blade or file fits into the holder. The Mid-States Equipment Corp., of Chicago, is the manufacturer.

Lightning-Quick Grip Assured on Screwless Vise

A PUSH or pull on the knob and an easy press on the lever lock work in place on the recessed parallels of the Grip-Master, a revolutionary screwless vise, put out by National Machine Tool Co., Racine, Wis.

Automatic-Feed Soldering Iron Ejects Fixed Amount of Solder

AN automatic-feed, electric soldering iron, the Eject-O-Matic (below), is trigger-operated and deposits a measured amount of solder from a reel in the bakelite handle. Excessive heat is dissipated by the nine graduated cooling vanes. Manufacturer is Multi-Products Tool Co., Newark, N. J.

Ratcheting, Open-End Wrench Has Compound Leverage

THE compound-leverage characteristic and the notched jaws of the ratcheting, open-end wrench at the left give the tool a sure grip on any shaped nut. The fact that it ratchets makes it unnecessary to remove the wrench until the tightening or loosening job is finished. The absence of the spanner-type upper jaw permits the slender tool, which was designed by George Logan, of New Hope, Pa., to get succeeding grips on a nut that is fixed in close quarters.

GLIDER *has reserve* POWER

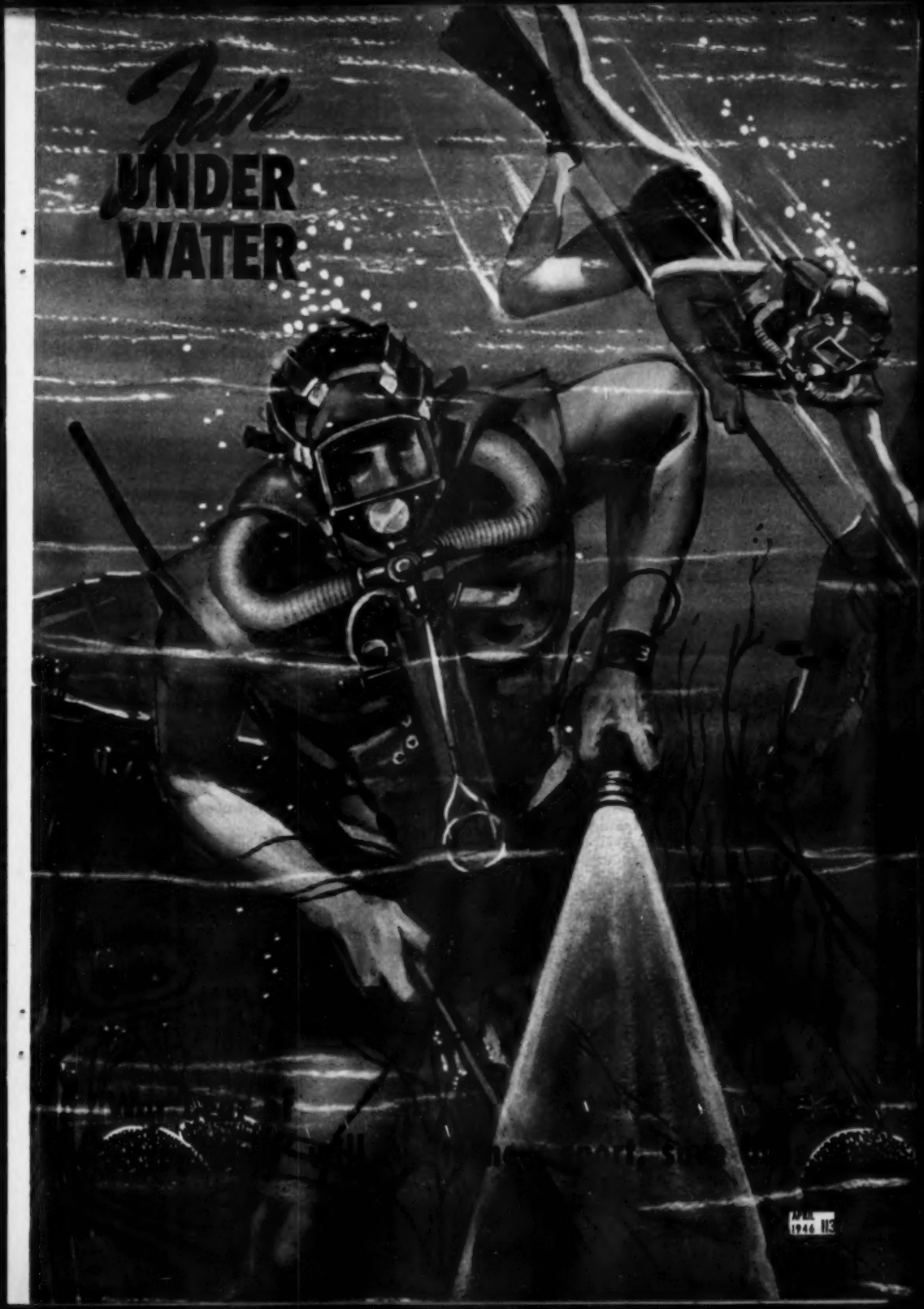
BUMBLEBEE, new two-place glider, uses an engine to take off and, if needed, to climb and return.

DESIGNER Hawley Bowlus checks ship's 16-hp., four-cylinder motor.

ALL PLYWOOD except for the boom sustaining the tail, dual-controlled Bumblebee's wing span is 46½ feet, length, 18 feet.

REAR VIEW shows 42-inch pusher propeller. Tricycle landing gear is retractable.

GLIDER weighs only 465 pounds empty and can carry a 350-pound payload. Tiny engine can drive the ship an hour and a half at 75 m.p.h.


Fun
UNDER
WATER

Two "frog men," Navy underwater demolition experts, explain weird attire to a California mermaid.

By HARRY SHERSHOW

OUT of the wealth of atom bombs, flame throwers, booby traps, and other World War II inventions, have come some devices that promise to survive and become indispensable in peace. Among them are oxygen-charged respiratory units, perfected for the Army and Navy for underwater offensives against the enemy. Like DDT and the jeep, these breathing machines will be of service to anyone who learns to use them.

Several such breathing devices cropped up during the war. One of them, the Lambertsen Unit, was invented in 1940 by a mechanically-inclined medical student, Christopher Lambertsen, who designed it originally as an appliance to help him become a better swimmer. Once he had tried his device successfully in the water several times, he decided that he had something more than merely a swimming aid, so he trudged to Washington and offered it to the Navy. After thinking about it and testing it, the Navy filed his idea and apparently forgot it. But two years later, the invention was rescued from the files and turned over to the Office of Strategic Services, which was then being organized.

Lambertsen received a commission in the Army Medical Corps, was assigned to the OSS, and was asked to muzzle his invention so that it wouldn't give off any telltale air bubbles. At the time, that was a problem comparable to stopping soda pop from fizzing. But by introducing a canister of special soda lime, which absorbed carbon dioxide and sent the rest of the swimmer's exhalations along through the system to be used over again, Lambertsen made a "non-effervescing" rebreather. The improved device was accepted by the OSS for its special underwater squad of "frog men," a name coined by the British to describe their underwater warriors (PSM, Dec. '45, p. 121). Lambertsen, then a captain, joined the frog squad as an instructor.

In its comparatively brief Army career, the unit was successfully employed by the frog men in a number of various activities, both in and out of water, including salvage operations, damage control on shipboard, some underwater attacks on enemy shipping, beach reconnaissance, underwater demolition work, and repair and inspection of docks and ships' bottoms. Now, with its war mission honorably completed, the Lambertsen Unit gives promise of becoming more popular and more practicable, according to its enthusiastic inventor.

Commercially, says Captain Lambertsen, it can be used in mine rescue work, fire fighting, rescue of persons from burning planes, buses and trains; and for damage control in smoke-filled or flooded ships' compartments. Furthermore, it can be used for quick salvage of planes sunk in less than 100 feet of water. Boat owners will probably find the unit invaluable in recovering lost anchors, straightening out lines that have become fouled about propellers, and replacing or inspecting mooring buoys.

But users of the Lambertsen Unit will also be able to create new water sports and introduce both good and poor swimmers to a new and fanciful realm.

The Lambertsen unit, however, does have

Lambertsen Unit is a vest, which supports ballast and inflatable bladders, and a respiratory system.

its limitations. Diving to depths of more than 60 feet is not recommended, because of the danger of poisoning from oxygen, which becomes quite toxic at high pressures. At 60 feet, though, a swimmer can stay down for about 45 minutes, long enough for a quick rubber of underwater bridge. In depths of less than 30 feet he can stay down for longer periods, sometimes as long as 24 hours. Water temperature, however, has a good deal to do with how long a swimmer can stay under.

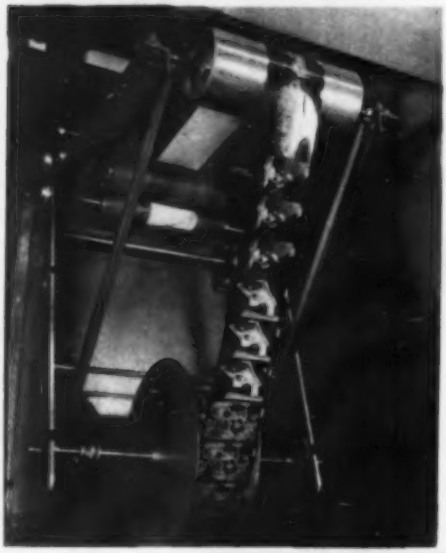
Underwater swimming involves risks, no greater in number, perhaps, than those of football or ice hockey, but a little different in character. Wearers of pure-oxygen breathing units are subject to such accidents as suffocation, carbon dioxide accumulation, oxygen poisoning, sinus pain, ruptured lung, ruptured eardrum, infections of the external ear, or pain in the middle ear. All such accidents, fortunately, are preventable, just as ducking at the right moment in a ring might save a boxer from a broken nose. Captain Lambertsen's system of preventing underwater mishaps includes going down only to modest depths, making certain that the equipment is in good order, breathing properly, and descending and ascending at moderate rates of speed.

Reputedly dangerous forms of marine life also loom as potential hazards to the submarine explorer. But Captain Lambertsen reports that although his men came in frequent contact with many jellyfish, sharks, barracuda, eels, rays, and octopuses, there were no serious tussles with any of them. One swimmer even became so daring and playful, says the captain, that he kicked an inquisitive shark in the belly and got away with it.

Illustrations by
HUNTER WOOD

Equipped for underwater exploring or, as the Red Cross thinks the Lambertsen Unit may be used, for life saving, this man has dispensed with the rubber suit, but wears fins for swimming long distances beneath surface. Dial on his wrist is a depth gauge.

Photoflood lamp gives odd look to machine that makes 300 color prints an hour. Below: Roll of prints ends 2,000-foot ride through developing, rinsing, fixing, bleaching baths, and past driers.



COLOR PRINTING
by the yard

A NEW assembly-line technique is turning out as many as 300 prints an hour from Kodachrome and Ansco transparencies, providing seven-day service to the growing army of color photographers. The speedy apparatus that makes this possible has recently been put to work by Pavelle Color, Inc., at its plant in New York City. Electronic controls in the enlarging machines make them function almost automatically in blowing up 35-mm. transparencies to 3 by 4½-inch "Printon" prints.

Human judgment is still needed to decide the best exposure range for the principal subject matter on a color transparency. But once expert coders have marked a frame "normal," or with a double or single plus or minus sign, the printing-machine operator has merely to press a correspondingly marked button to obtain a proper exposure for each frame.

As light from an R-2 photoflood lamp shines through a transparency, one image is projected on printing material (passing through the machine on a 240-foot roll) and another is thrown horizontally toward a photoelectric cell in the housing at the rear of the machine. The cell, assisted by a battery of electronic tubes behind it, determines each exposure on the basis of the total light that passes through the film. The amount of light therefore must be controlled, and is gauged by the button that the operator pushes. Prints are clipped and mounted as they come off the assembly line.

From transparencies this size come prints as large as the one at right. Pavelle Color, Inc., now mass produces only 3 by 4½-inch prints, will make other sizes as it obtains equipment.

Red, White and GOLD Children of Weeds

FLOWER experts call them "mums." They are the elegant hybridized grandchildren of rank, weedy plants closely related to the daisy. Hundreds of varieties of these chrysanthemums have been developed, ranging from vest-button-sized pompons to blossoms the size of a hat. Some are smooth. Some are shaggy.

On the 65-acre farm of Robert L. Smith in California's San Fernando Valley, they are propagated, raised, picked, and packed in new ways. Not only does Smith carry out his purpose of growing bigger, better, and longer-lived flowers, but he ships them by air to national and international flower markets.

At one time of the year or another, every section of the United States gets a crack at the national flower market. California's chance arrives when the first cold snap of

New shipping techniques speed California chrysanthemums to distant markets. A few minutes after the flowers are picked, a girl removes them from water to prepare for shipment by air.

Each flower is put in its place individually as first operation in wrapping the mums for air shipment, a smooth roll or pad of paper bracing the stem a few inches under the bloom. A bunch of one dozen will be composed of three rows of flowers, four units to a row.

A bunch of a dozen large white blossoms gets its fourth and last paper pad before being tied for the trip to market.

These big aristocrats of the chrysanthemum gardens grow only one flower to the plant. They are raised under cloth, and six months of care are necessary to bring the flowers to the king size shown here.

November hits the eastern and southeastern states. Then the sun-flooded slopes of San Fernando start pouring a $3,000,000 winter flower crop into the market by air—field-fresh when they reach New York and other seaboard cities.

Mums go to market in two general forms. One form is grown in cloth houses; the other in open fields. Those grown under cloth are given special treatment. Skilled workers remove branches and buds from the young growing plants, forcing the plants to grow only one stem, with one bud at the top. With all its energy directed into a single flower, the result is a super-blossom, the aristocrat of the flower shop. A second type of control permits a cloth-house mum to grow two to four branches, with one flower per branch. These are called China mums, have smaller flowers and shorter stems.

Field-grown mums begin from the same stock as the fancier blossoms, but their branches and buds have not been nipped. Therefore the bloom is not restrained, and each acre of them will produce over 4,000,000 flowers.

The chrysanthemum plant is a perennial, but these horticulturists start over again each year with cuttings taken from the preceding year's best plants. The cuttings are placed in sterilized sand where they are fed a scientific diet of chemicals. Each cutting develops a huge root system, and by late spring, planters set out the rooted cuttings. Those for big mums and Chinas get their start in the cloth house; those for field mums are planted in the open. Painstaking

No chances are taken that may result in the flowers being damaged in transit. After string has been tied firmly around the paper pads, more is wound around stems in the manner shown by the photo.

There's still more to the packaging process. After the stems have been tied together, waxed paper goes around the bunch of flowers as protection from air.

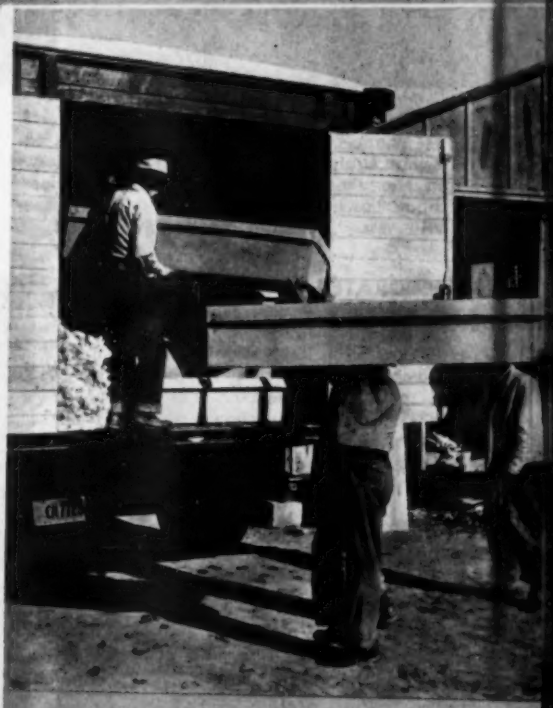
Looking into the open end of a bunch of large Number One white chrysanthemums as they appear just before leaving the packing shed direct for the airport. Less than 24 hours later they'll reach markets.

preparation of the soil gives the young plants a chance to grow rapidly. The soil is deeply worked, and is de-weeded, debugged, fertilized, and irrigated. Overhead spray can be turned on when needed. Aside from drought, which can be minimized by irrigation, the mum's chief enemies are heat, wind, and birds. Every time a sparrow nips a petal from one of the big blossoms, the grower loses 50 cents. A 20-minute foray into a mum field by a flock of birds can do $20,000 damage.

Production-line principles are used in the fields and packing sheds. At picking time, only experts cut the big mums and Chinas. In bunches of a dozen the flowers are carried from the cloth house to a packing shed, where they are lifted, one at a time, and critically examined. Workers place each flower stem-down in tanks of clean cold water—a tank for each grade of flower—within 20 minutes of the time of picking.

Picking begins at a designated number of minutes before plane time. Flowers must be fresh when they reach the market. The pickers and packers do not lose a minute, but they have time to work carefully. The choicer flowers are arranged in bunches for shipping, packaged between smooth pads of rolled paper, and covered with waxed paper. The field mums can stand the plane journey unpackaged, but the big ones are usually boxed in a new type of streamlined flower-shipping carton that combines lightness with strength.

The next day the flowers are decorating somebody's table on the eastern seaboard.



The light, strong shipping boxes were designed especially for use in the air transport of flowers. The blossoms being loaded on the truck have been picked about one hour. They are taken directly to the airport near Los Angeles, where they are put aboard a plane and whisked to Atlantic seaboard in jig time.

GADGETRY GOES WILD in this convertible coupe of John Towber's. He has radio-repair equipment behind the seats, as shown in the photo at left. That's for business, since Towber runs a radio shop in Coatesville, Pa. The front of the car is given to pleasure—on the dash are running water, air conditioning, a movie screen, and a phonograph with automatic record changing. On the left-front fender is an electric-eye headlight dimmer. But turn to page 141 for the story of this super-accessoried car.

DECORATED HOPE CHEST. This example of Pennsylvania Dutch workmanship, ornamented with colorful designs, is in keeping with the spirit of the early German settlers who delighted in painted embellishments. How to make the chest is shown on page 152.

EVER WANT A STEAM TUG? Here's one in model size that runs under its own power. With a balsa hull, oilcan boiler, and homemade oscillating engine, it is built, as described on page 154, with a minimum of tools.

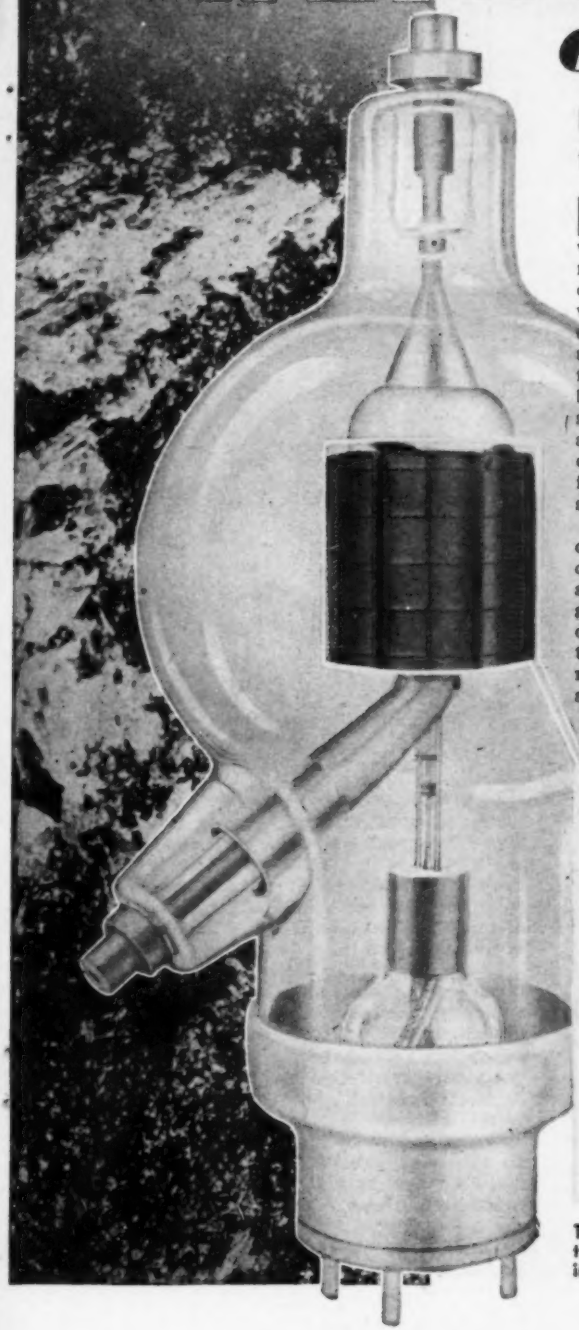
TANTALUM

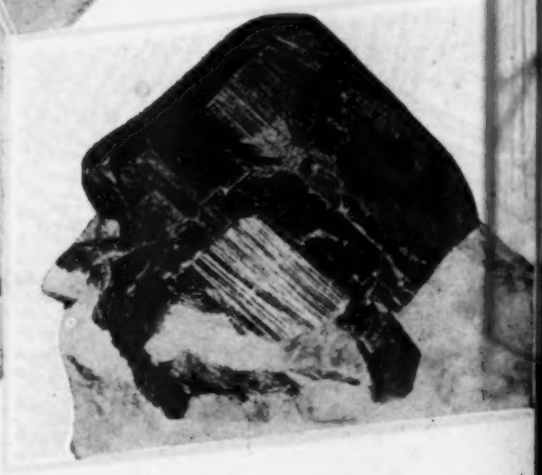
Goes to Work

Rare metal improves radio tubes; mends broken bones.

FEW people may ever have heard of tantalum—a rare metal seven times as valuable as precious silver, which it closely resembles. But the nation needed tantalum desperately, not so long ago, for such varied war purposes as radio tubes, surgical plates, and tool alloys. Brazil's entire production, more than half of the world's, was being flown to the U. S.; a WPB order, M-156, forbade shipping more than *one ounce* of the strategic metal to any customer without an allocating order. Now that America has a comparatively sufficient supply of tantalum, it is being put to so many uses that its name should soon become familiar to everyone.

The strains of your favorite symphony come to you more richly via the radio because of tantalum. It is used in the plates and grids of transmitting tubes ranging in size from those of big transmitting stations down to the midget power tubes of "walkie-talkie" sets. This application stems from its remarkable effectiveness as a "getter" or absorber of unwanted gases in the tube.



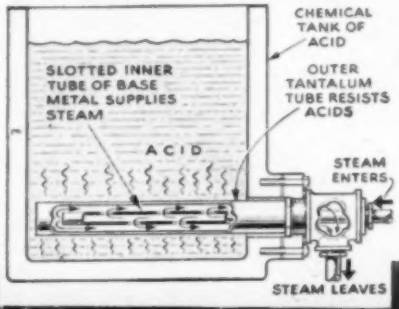


Tantalum serves for the plates and grids in many types of radio transmitting tubes. Above is specimen of tantalite, ore from which tantalum comes.

Ranking among the noble metals in resistance to corrosive acids and other chemicals, tantalum defies attack even by boiling aqua regia, the "royal water" that dissolves gold. This accounts for innumerable other personal, domestic, and industrial uses of the magic metal. For example, it serves air travelers who have been bothered by leaky fountain pens. Following a simple law of physics, air in the ink chamber of many pens expands and forces out the ink when high flying reduces outside air pressure. This can be prevented by a tiny valve built into the pen—and made of tantalum, to resist corrosion from some kinds of ink.

In the hands of skilled surgeons, tantalum has proved one of the few known substances so chemically inert that, judging from experiments so far, it can be left permanently in the human body.

The metal solves the problem of how to heat a tankful of corrosive liquid efficiently. The diagram below shows tantalum's use in the resisting of acid.



Ten-foot crystals of spodumene form the teeth of the "Dragon's Mouth," from which the ore is taken. Tools shown employ a tantalum alloy.

Severed nerves have been loosened, and their ends grafted together, with tantalum wire drawn so fine that the surgeons cannot see it but work with it by sense of feel. Protective sheaths for literally frayed nerves have been formed from microscopic tubes of rolled-up tantalum foil, less than 1/1,000 of an inch thick.

In the chemical industry, whose wizardry turns searing acids and noxious brews into explosives or perfumes, tantalum metal probably finds its most extensive use. It solves what should be the simplest problem —actually one of the most perplexing—how to heat a tankful of a highly corrosive liquid most efficiently. An accompanying diagram shows how two concentric tubes do the trick. The tantalum tube may be made so thin that it transmits almost as much heat through its walls as if they were not there.

Large machine tools employ inserted blades of an alloy containing tantalum;

small ones consist of the solid alloy, and after casting need surprisingly little finishing.

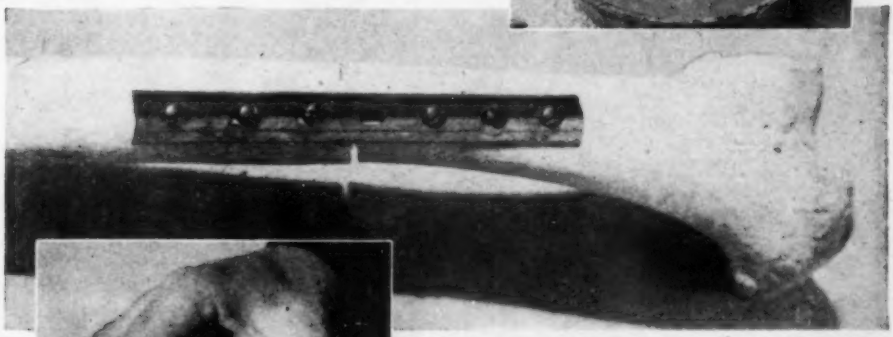
Finding enough tantalum remains a problem. Few spots on earth yield it plentifully. The principal ore, coal-black tantalite, was until recently separable only with utmost difficulty from the associated mineral, columbite, containing its twin metal, columbium. The Swedish chemist who first succeeded aptly named his trophy after the word "tantalize."

Specks of another tantalum ore, a honey-colored deposit called microlite, have been found scattered in a white matrix of other minerals. Formerly they were not considered worth mining. Now high-grade microlite from a Taos County, N. M., mine, spangled with quantities of the ore, is believed the first to yield paying quantities.

As surprising as finding a dinosaur with its skin on, this mine offers a treat to geologists in an almost perfectly preserved pegmatite dike, a volcanic formation of granite. Ten-foot-high crystals of spodumene, a mineral found in white, gray, and colored tints, overhang the interior, where diamond-drilling experts of the U. S. Geological Survey helped the owner map tantalum deposits. Starting in December, 1942, workers took out 40 tons of crude ore in three months. Reduced to concentrates, or semirefined ore, the honey-colored mass was worth nearly $25,000. And in 1943, the mine yielded about nine times the total from all others in the United States.

Standard forms of pure tantalum metal available today include bars, rods, sheet, foil, tubing, wire, and ribbon rolled from wire.

The Brazilian (right) is panning tantalite, as with gold-bearing dirt. Model below shows how a tantalum splint, inert to body chemicals, mends fracture.

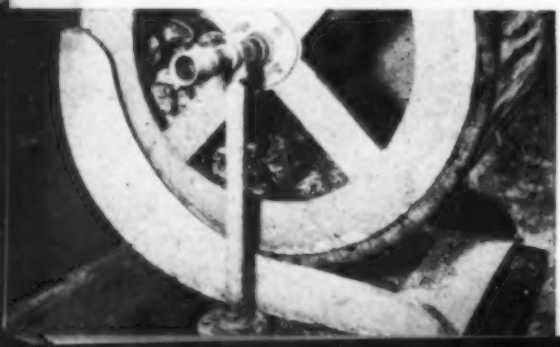


On this lightning arrester designed for use with railroad signals, the hanging disks and connecting wires are made of tantalum.

Dr. Herbert Prytherch with his oyster - opening machine, which spins the shellfish and sprays them with water, causing them to unclamp. Later bath in soda water keeps the oysters open.

Opening Oysters the Easy Way

Soda water poured over the oysters, says Dr. Prytherch, does not harm them, but helps preserve flavor. Below is a simple version of the tumbling machine.



THE experts can open oysters by the bushel with a twist of the wrist and a flick of the strong, two-edged oyster knife. Now comes a scientific trick that enables even a fresh-water farmer to open the toughest oyster without bruising a knuckle or shucking a curse.

In a miniature "washing machine" the oysters are simultaneously tumbled and sprayed with fine jets of water. Then they are dumped into carbonated water, after which the shell virtually falls off.

The inventor, Dr. Herbert F. Prytherch, head of the U. S. Fisheries Laboratory, Beaufort, N. C., got his idea from the starfish, greatest of the oyster-bar addicts. The starfish wraps its five arms around the oyster and injects into the shell some natural anesthetic. Muscles relax and the shell opens. Dr. Prytherch used club soda for knockout drops; the tumbling was to get the oyster groggy. Later he found that tumbling alone did the trick.

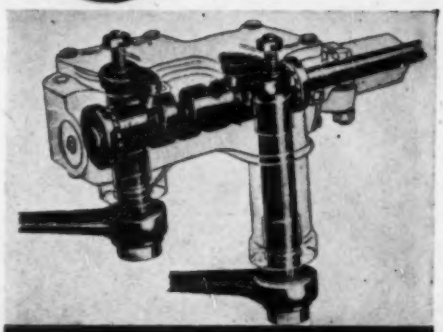
FOUR Wheel STEER

Berg's highly dexterous jeep takes to the woods.

Circus Jeep Goes Sideways to Wriggle Through Traffic and Trees.

THOUGH it was built to perform in a circus, a trick jeep that can move sideways and turn around in its own length has practical uses as well. Equipped with a front axle both in back and in front, the Army car of all work was made over for its starring role by the Berg Truck & Parts Co., of Chicago.

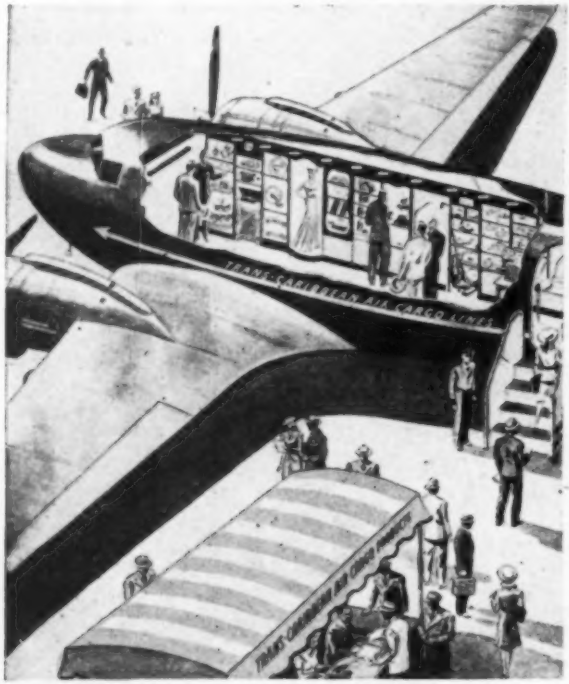
With all four wheels perfectly aligned and linked to one steering column through steering knuckles on both axles, the jeep squirms through tight places like a quarterback and can be parked in a space of less than 14 feet. Such agility makes it a possibility for hunters, forest rangers, and others who need nimble transportation.



Steering-gear assembly of the converted Army car.

Republic XF-12 Heralds New Era in Global Transportation

THE long secret Republic XF-12 (PSM, March '46, p. 94) in test flights has proved itself the fastest long-range, four-engine transport-type airplane in the world. The Air Technical Service Command has released partial performance figures, stating that the sky giant will operate at a speed over 450 m.p.h., with a service ceiling above 44,000 feet, and an expected range of 4,500 miles. The XF-12 is the military version of the 46-passenger Republic Rainbow, scheduled for delivery to airlines in 1947.



Flying Showroom Tours Latin America

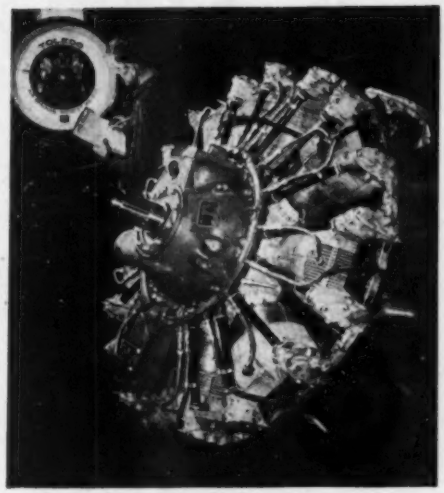
ANOTHER first in aviation is now taking place. History's first flying showroom has been prepared to tour 16 major cities in 11 different countries of South and Central America. In 28 specially fitted booths on a DC-3, jewelry, perfumes, plastic products, chemicals and hardware, drugs, ladies' wear, and other American products are to be exhibited to our Latin-American neighbors in this spectacular innovation in merchandising and selling.

Operated by Trans-Caribbean Air Cargo Lines, the plane has a team of Spanish- and Portuguese-speaking demonstrators to show the products at each stop on its journey, which will last 35 days and cover 16,975 miles.

Trans-Caribbean also is organizing a subsidiary to act as agent and distributor for a number of North American manufacturers.

Portable Is Three-Way Radio

THE portable Learavian (below) offers reception on the ground or in the air and has an interphone feature for the pilot to talk with his passenger or instructor with his student. Its three bands cover range and control-tower reception, standard broadcast, and intraplane communication.

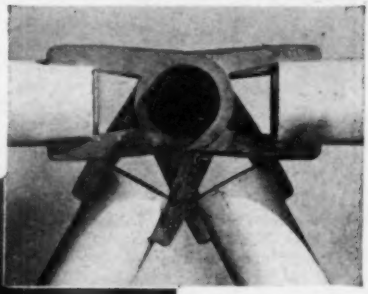


Power-for-Weight Champion

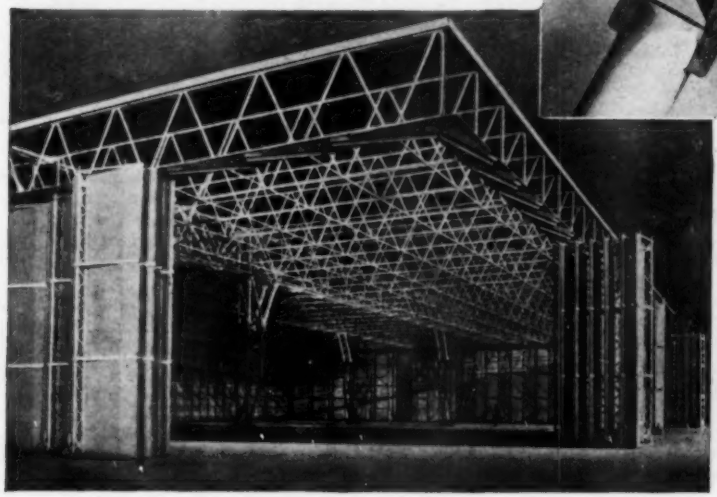
THE new Wright Cyclone 9HD (above) is the world's lightest air-cooled radial aircraft engine per horsepower. It develops 1,425 horsepower and weighs only 1,352 pounds, equal to one horsepower for each .95 pound.

Hangar Made of Metal Tubes Features Removable Wall

USING shop-fabricated, standard metal tubes in a new method of construction, the Atlas Aircraft Products Corp. shows in the model below how airplane hangars featuring removable walls may be put up speedily and inexpensively. The basic elements making the method possible are the new mobilar-tube joint and the removable wall unit.



This mobilar-tube joint eliminates all riveting and hand-welding. Eyeplates of the metal tubes are held together with a simple bolt.



The entire mobilar structure is shop fabricated. A wall unit can be removed without affecting structural load of the building.

"EXERCISE MUSKOX"

Explores Arctic Canada

Snowmobiles with heated cabins that bunk four carry the "Muskox" expedition northward.

FOUR dozen men of the Canadian Army are now rolling across the frozen, windlashed wastelands of the Far North in snowmobiles, on a three-month, 3,100-mile journey of exploration called "Exercise Muskox." Their mission is to obtain new information about vast regions of their country that lie mostly within the Arctic Circle, and to test many kinds of equipment and clothing designed to withstand the rigors of unrelenting sub-zero weather.

Riding in snowmobiles that have plate-glass windows, wide caterpillar treads, and can travel 30 miles an hour, the men of the Muskox expedition wear seven layers of clothing. "Fish-net" underwear is next to their skin; then come regulation khaki underwear with reinforced parts, a heavy flannel shirt, special high-neck sweater, battle dress treated to repel water, a pile liner for the parka, and finally the parka, trimmed with wolf fur. Two scarves, one of normal wool and the other of material like that in the fish-net underwear, insulate the paunchy outfit.

To provide further protection against the dangerous climate they must face, troops on Exercise Muskox wear "breather" goggles, which were originally designed to be worn in dusty air but have been found to take

Sturdy Dakotas (C-47s) will drop supplies ahead of the Canadian Army's snowmobile convoy as it winds across thousands of miles of barren, icy wastes within and south of the Arctic Circle. One of the planes is shown warming up on an American-built airfield in northern Manitoba.

the biting edge off extremely cold air.

The expedition, under the command of Lt. Col. P. D. Baird, left Churchill, Manitoba, in mid-February. Churchill is a port on Hudson's Bay where U. S. Army Air Forces built a camp and airfield early in the war. On that airfield and at many other points that Exercise Muskox will reach, the Royal Canadian Air Force is faced with the problem of flying and servicing planes at temperatures 40° below zero and more. The Muskox expedition will end its long, circuitous trek across arctic and sub-arctic Canada at Edmonton, Alberta, in May.

"Breather" goggles, with polaroid eyepieces, protect men from frostbite of the lungs and snow blindness.

Camp comforts, when Exercise Muskox halts en route, include tents with nylon linings, which form an airspace between the outer wall and inside. Men sleep in feather-and-down bags, on caribou skins.

RADIO HOTFOOT

makes production jump

By J. D. RATCLIFF

Drawings by RAY PIOCH

THE most radical advance in heating since man first put fire to use is heating by radio waves.

In seconds, these magic waves can be used to heat steel white hot. Slowed down, they can be used to vulcanize rubber—producing a tire that promises to last the life of a car. Radio heat kills weevils in grain in elevators, makes better plywood, solders tin cans, even cooks hot dogs. There are jobs for it wherever heat is used in industry—just about everywhere.

"Radio heat is a discovery comparable in magnitude to invention of the telegraph," says C. J. Burnside, head of Westinghouse's industrial electronic division. "It is one of the biggest things ever to come over the industrial horizon. It will speed production, cut costs, and provide cleaner, more pleasant working conditions. It makes possible a host of new products that we could never attempt before."

In a moment we shall see some of the jobs opening up for radio heat. But first take a quick look at its source. Early experimenters noted that an iron bar heated up if it were placed inside a coil carrying alternating current. Electricity in the coil induced a current in the bar. The bar's resistance to the current's passage—friction of the current in the bar, so to speak—generated heat.

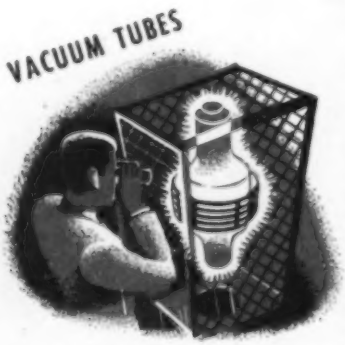
Not long afterwards, researchers stumbled on another form of radio heat. They found that if a nonconducting material (such as glass, rubber, wood) were placed between two plates charged with alternating current, the nonconductive material got hot. The current surging back and forth tugged the molecules in the material first in one direction, then another. The result was molecular friction—expressed as heat.

This was dielectric heating. Its most striking feature: it created heat *inside* a material, instead of forcing it in from the *outside* as does every other form of heating.

No one realized the importance of these twin discoveries. Besides, the equipment needed for efficient application of the idea wasn't available. High-capacity vacuum tubes to produce 200,000,000 alternations per second had yet to be invented. (The usual household current alternates at the rate of 60 cycles a second.)

In 1921, General Electric hit upon induction as the solution of the tricky problem of how to drive trapped gases out of metal filaments in vacuum tubes, before the tubes were sealed. Heat applied externally would crack the glass. Induction heating—which would heat the filaments, but not the glass—was the answer.

Eight years later, men in a short-wave broadcasting station noted that they became feverish when working near large vacuum tubes. Dr. Willis Whitney of General Electric reasoned that fever was caused by short-wave radiation passing through their bodies. This led to the artificial-fever ma-



chines that are now found in most large hospitals.

After these two relatively minor applications, radio heat lay dormant until the war years. Then came swift developments. The most dramatic of the lot was radio heat's role in rescuing America from a critical tin shortage.

Traditionally, tin plate is made by dipping thin steel sheets in molten tin. Research men found they could get by with a third the amount of tin if it were applied to steel electrolytically. But there was a catch. Tin didn't cover the steel in an even film. There were microscopic mountains of the metal, and microscopic valleys in which there was no tin—hence cans would quickly pit with rust.

Radio heat solved the problem. As the strip of electrolytic tin plate flashed through the coils at the rate of 1,000 feet a minute, enough heat was produced to melt the tin into an even, shiny film. The radio tubes in the tin mills use more power than all the radio broadcasting stations in the United States put together. This process not only tripled our stock pile of tin, but it also speeded tin-plate production. Without it America would have had to get along on only a fraction of the canned goods normally used.

Plywood is ordinarily cured in kilns or between steam-heated plates. It takes hours or days for heat to penetrate to the core of the slab. Often the plastic glues on outside surfaces cure before heat even reaches to the middle. This is the factor that has limited the thickness of plywood sections to an inch or so.

Dielectric heat instantaneously gets heat to the middle of the slab. In many instances it reduces setting time from hours to minutes, thus enormously speeding production. Plywood spars for planes were made seven times as fast when radio heat was adopted. Plywood boats used for rescue of fliers downed at sea were made in 26 days instead of six months. Radio heat enormously speeded up the production of Britain's famous plywood plane, the Mosquito bomber.

From now on the plywood industry can make forms of any shape or any thickness. The way is open for heavy building timbers, furniture, and boats that could never before be made of plywood.

Plastics present much the same problems as plywood. Heat from steam presses penetrates slowly, resulting in uneven cures. Radio waves have speeded production and improved products. In making telephone cradles, for example, radio heat upped production 56 percent while cutting costs 40 percent. Radio heat has been similarly valuable in sealing plastic shower curtains, raincoats, and even ping-pong balls.

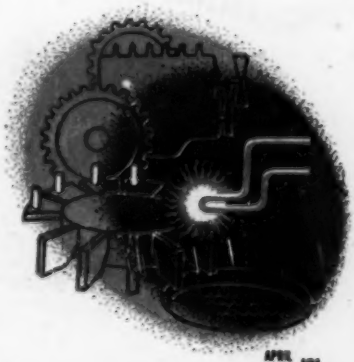
The reason most plastic objects you see are little things like light plugs, ash trays, knobs, and buttons is this difficulty of getting steam heat to the middle of any larger mold. Radio heat opens the way for plastics in any shape or form. Plastic doors, window frames, and building panels, for example, are distinct possibilities.

Radio heat is helping to build television sets you will be able to afford. The projection-principle

TIN PLATE

PLYWOOD

METAL HARDENING



SEAM WELDING

PLASTICS

VULCANIZING

television system developed by RCA enlarges the image in a five-inch tube until it fills an 18- by 24-inch screen. This is done by reflecting the picture in an enlarging mirror, then passing it through a corrective lens, which makes the image still bigger. Made of optical glass, the mirror and lens would cost $100 each. Made of plastics by an induction-heat process, the mirror costs about $12, the lens around $10. The $178 saving will do much to bring the cost of a good television receiver down to the size of the average pocketbook.

Glass, preheated until it conducts electricity, can be welded as a result. Systems of glass pipe used in certain industrial processes can be made in one piece electrically.

The metalworking industries see many possibilities. The Budd Induction Heating Co., of Detroit, has a machine that heats a steel bar 1⅝ inches thick to 2700° Fahrenheit in eight seconds. Another Budd machine, no bigger than a large home radio, handles five tons of steel billets an hour. The billets go in one end cold, come out the other cherry red, ready for forging. The machine occupies only a third of the floor space required by conventional ovens and keeps the plant much cooler in summer.

An outstanding advantage of induction heating is that heat may be applied to any area wanted. When that area is quenched with water, superhard steel results. This idea is being applied to cylinder linings for tractor engines, producing a thin film of hard steel that is virtually everlasting. It is also being used to harden gear teeth to prevent wear.

Budd engineers have thus hardened millions of auto hubs. They think their idea will find application wherever two pieces of metal rub together. It should give lifetime utility to any number of such household gadgets as sewing machines, lawn mowers, or electric mixers.

Rubber insulators on Firestone Tire & Rubber Company's short-wave radio station kept breaking down. It developed that they were being heated by the high-frequency currents. G. P. Bosomworth, Firestone research engineer, had a brilliant hunch. Why not use radio heat to vulcanize rubber? There were obvious advantages. It takes seven hours to cure a big truck tire in a steam mold. A large tire plant has millions of dollars invested in molds. If they could be made to produce tires faster, the saving would be a big item. Furthermore, a better, more uniform cure would be translated into longer tire life.

Bosomworth found that radio heat would vulcanize an auto tire in 10 minutes—as against 50 minutes in a steam mold. Similarly, it took only a fifth the time with huge truck and plane tires. Plans are now underway for a tire plant. And already Firestone is using electronic equipment in its Fall River, Mass., plant to cure foamed latex mattresses and automobiles and train-seat cushions.

Radio Corporation of America employed radio heat to dry penicillin in 30 minutes instead of 24 hours.

In the food field, radio heat has dozens of obvious applications. It will be used by hotels to thaw

large packages of frozen foods. Mold is a big problem to bakers. Radio heat can be used to raise temperature of bread or cakes as they emerge from wrapping machines, thereby destroying mold (PSM, Feb. '46, p. 124). It has already been used to preheat peanuts for peanut brittle.

General Electric has a down-to-earth application—a food vending machine. Put a dime in the slot and it instantaneously heats ready-wrapped hamburgers, hot dogs, cheese sandwiches. The heat, incidentally, heats the meat and cheese, not the bun or wrapper, because the sandwich fillings have higher electrical resistance.

Radio cookery may find some application in the home, but from present evidence not much. A ham, for example, contains fat, bone, and lean meat—all of which cook at different rates in a radio oven—as one experimenter learned when a ham blew up. Radio heat, however, might be used to cook such homogeneous foods as meat loaf, rolled roasts, or bread.

Radio heat found thousands of random uses in war production, beyond those already mentioned. RCA engineers worked out a means of using it to dry powder for rocket charges—cutting the oven-drying time from 24 hours down to 10 minutes. Another novel use: setting off the charge in explosive rivets. In such rivets a small explosive charge goes off, flattening the rivet head in spaces too small to admit a man—in tail sections of fighter planes, for example.

Radio heat fits perfectly into the mass-production picture. It takes many complicated heating operations out of the hands of the highly skilled. In one plant, specially trained men were able to solder 100 can necks an hour—doing the job so fast that paint on the cans didn't blister. Radio heat, focused on the necks, soldered 2,500 cans an hour—doing the job so fast that paint on the cans didn't blister.

Still another type of radio heat is used in resistance welding. A flat strip of steel is curled into pipe form, then a flash of current welds the two edges together. This process hastened production of big pipe used in wartime pipe lines, including those invasion pipe lines that carried gasoline to tank spearheads in Africa and Europe.

Only one job has completely stumped engineers. An undertaker directed a query to Westinghouse. Did radio heat have any application in embalming? They shuddered and said no.

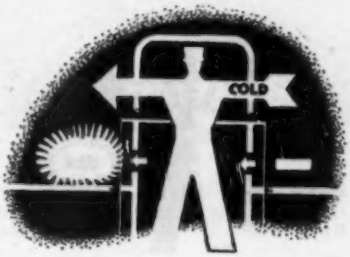
For good reason, radio heat has captured the imagination of industry. Not long ago a meeting was held in Chicago to discuss new jobs for the invisible electric flame. The sponsors of the meeting expected a hundred or so people to attend. They were astounded to receive more than 5,000 applications for tickets!

Every conquest of heat has meant a step forward in human development: fire for warmth, fire for cooking, fire for mechanical energy. Radio heat now takes its place alongside these epochal developments as one of the fundamental engineering advances of our day.

DRYING PENICILLIN

FOOD

METALWORKING



A stepped-up Ford roadster roars across the finish line bettering 100 m.p.h. on the Mojave Desert.

Jazzed-Up Jaloppies

EX-GIs USE SERVICE KNOW-HOW TO SPEED UP FORDS AND CHEVVIES

The timing crew operates from the top of an old coupe. Already, it has officially clocked the following records: Bob Bebeck, standard Ford roadster, 123.71 m.p.h.; Karl Orr, modified Ford roadster, 133.03; Bob Rufi, streamlined Chevrolet, 140.

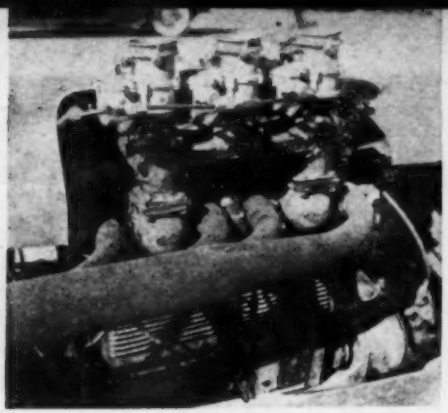
WITH tricks they learned while repairing jeeps in New Guinea, tanks in Germany, and airplane engines at bases throughout the world, ex-GIs are doctoring up run-of-the-mill, prewar jaloppies and assaulting old speed records. Several score veterans of Southern California towns have been gathering on week ends at a group of dry lakes on the Mojave Desert. There, in self-made, streamlined versions of old Fords and Chevrolets, they speed over measured courses.

Prior to the war, 125 miles an hour was considered a good speed by such cars. Now, at least one car—a Chevvie—has smashed through the electrical timer at a 140-m.p.h. clip. Others have come close to that mark.

Contestants are allowed to make any changes in their cars that they like so long as they operate on standard makes. One driver shortened his Model A 20 inches to reduce its weight.

No driver is happy unless he betters his previous mark by a mile or two an hour. But that's all the satisfaction he gets from this daredevil pastime. There are no big cash prizes such as lure the speed merchants to the 500-mile Memorial Day classic in Indianapolis. These boys race simply for the fun of zipping along at breakneck speed, and for the joy of improving mechanically some of our standard engines.—ANDREW R. BOONE.

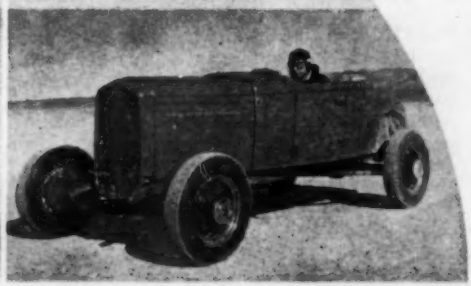
Don Blair, of South Pasadena, Calif., installs an interlocking-vane supercharger for ramming air into the intake manifold. The ex-serviceman has hit 134 miles per hour with this doctored-up engine.

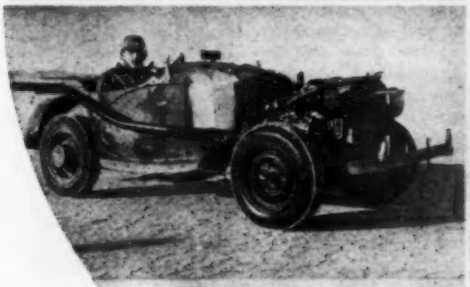


Not one but three carburetors feed this four-cylinder Model A Ford engine. They pour atomized fuel into the cylinders as fast as cylinders can pull it through the valves, greatly boosting motor's power.

This 1928 chassis houses a Model C 1933 Ford block. H. T. Markham, of the maritime service, stripped it down to save weight.

Arless Knight drove this speed wagon 12,000 miles on the highway, then reached 112 m.p.h. on a desert alkali racing strip.





Jack Ratledge, of Los Angeles, performed a major operation on this 1937 Ford, raced it at 103.02 m.p.h. (official).

This Mercury V-8 chassis, streamlined by owner-driver Vic Eddlebrock, of Hollywood, hits a speed of 130.5 m.p.h.

modern living

PLASTIC POT SCOURERS are a new item for kitchen-sink equipment. They are used with the customary pot-washing soaps and consist of tiny plastic beads anchored to a pad of minute cotton loops. The plastic used in them is plaskon resin, made by the Libby-Owens-Ford Plaskon Division, and the pads are manufactured by the Downy Products Company, of Orange, N. J.

WATCH STRAPS OF PLASTIC, said to resist deterioration under conditions that cause leather to rot, are now being produced by the Pla-Safe Plastics Corporation, of Buffalo. The new straps are made of polythene, a Du Pont plastic.

A COOL HANDLE, full control over pouring, and fast boiling are advantages claimed for a new kind of water kettle. Its walnut handle stays cool even if it is placed on one side of a burner. Water height is visible through a lidless filling spout, from which steam can't escape. It's made by Dr. Peter Schlumbohm, of New York.

PIPE SMOKERS who find their favorite briers sometimes get in the way will be interested in this leather holster that protects both the pipe and the clothing. It is worn on a belt or button. Moisture drains into a washable plastic cup fitting in the bottom of the holder.

RETRACTABLE ELECTRIC CORDS, first used in submarine and bomber intercommunication systems, are now available for household appliances. Their retractive qualities are molded in, making the cords kinkproof. The Kellogg Switchboard & Supply Co., of Chicago, is the manufacturer.

Their heads snapped back sharply as the car let out a squeal and swished ahead.

Customer

into a one-way thoroughfare jammed from curb to curb with cars moving infrequently a foot at a time to the irascible honking of horns.

Gus glided into the center file of traffic and eased to a smooth stop before noticing that the car just ahead was an ancient Rolls Royce of the once famous but now almost forgotten Silver Ghost model. Mrs. Miller, resplendent in wedding-guest finery, was driving; Henry, her husband, was sitting beside her looking sheepish and apprehensive.

Cars on either side moved ahead, leaving the Rolls and Gus's own modest car. Mrs. Miller had used first-class timing in introducing her new-old classy bus—a couple of dozen friends, acquaintances, and bitter social rivals were clustered on the sidewalk and the church steps, surprise and envy on their faces. Responding to the sensation she was causing, Mrs. Miller was so busy dispensing smiles and fluttery waves of her hand that she didn't see Officer Jim McMahon beckoning her on. Finally the outraged cop put everything he had into a blast of his whistle and yelled: "Step on it, lady!"

The policeman's roar and the jab of her husband's elbow shocked Mrs. Miller into a flurry of activity. She shifted into gear and let in the clutch—and then Gus saw her head and Henry's snap back sharply as the old car let out a squeal and swished suddenly ahead. All that saved Officer McMahon was that he used to be the star broad jumper on our high-school track team. The fender just scraped his coattails in his startled leap for life. He glared after the juggernaut and shook his head.

"Nuts to these high-society assignments," he complained. "They're too dangerous for a married man with children!"

Gus drove sedately to the parking space beyond the church. He was grinning.

"It won't be long now," he told himself as he left his car.

IT WASN'T long. About four o'clock that afternoon, his grouch gone because he was back in his work clothes and his shop, Gus was contentedly showing Stan how to machine a brake drum that had worn out of round when Mrs. Miller, still wearing her churchgoing best, came in with husband Henry in tow.

"Oh, Mr. Wilson," she gushed, "I saw you at the wedding—and wasn't it just too, too *beautiful!*—and it set me to thinking how *sad* it is when old friends allow even the *tiniest* little bit of misunderstanding to come between them! When I saw you in church today—and looking very handsome, too, wasn't he, Henry dear?—I said to myself, 'I'll let bygones *be* bygones, and I'll take the first step . . .' "

"That's fine of you, Mrs. Miller," Gus interrupted. "Let's forget the whole thing. After all, I'm paid to fix cars, not to tell people how they should drive 'em."

"You mustn't feel that way, you positively *mustn't!*" Mrs. Miller told him. "The advice you give is always so *valuable*. Oh, that reminds me—we've got a new car, Mr. Wilson. Well, not exactly a new one, but it's a Rolls Royce. Just think, Mr. Wilson, poor little suburban me with a *real Rolls Royce!* When I saw it down in the city I fell right in love with it—it looked so, so *aristocratic*—and I made Henry buy it for me. It's a marvelous car, but you just can't *imagine* the disconcerting things it does!"

"Oh, yes, I can," Gus said, grinning. "I was right behind you this noon when you nearly ran that cop up a tree."

Mrs. Miller's face reddened to match her rouge. "Oh," she said weakly, "so you know. Well, it was very embarrassing because I promised Gloria Knowles—I should say Mrs.

Then he took out the piston rod and held it up. It was coated with gummy deposit.

Wilburn now, shouldn't I?—that she and Cecil could use it for their wedding trip."

Henry Miller opened his mouth for the first time. "I phoned the concern I bought it from," he said glumly, "and they told me a new clutch would cost $600. Holy suffering cats—six hundred smackers for a clutch, and I only paid two hundred for the car!"

"Henry!" his wife reproved. "We promised the salesman we'd keep the price confidential because it was such a *wonderful* bargain."

"Bargain!" Henry grunted. "The clutch ain't all that's the matter with that bus, Gus. Its carburetor's shot, too. Swell bargain!"

"Maybe things aren't quite as bad as they seem," Gus told him encouragingly. "I had a lot to do with Rolls cars in the old days. There's never been a finer automobile than these old Silver Ghosts, but you have to be on to a few of their peculiarities to get anywhere with them, and although there are a lot of them still around, mighty few present-day mechanics know anything about them. Stan! Drive Mrs. Miller's car in."

Stan drove it in and got out shaking his head. "It looks like a million," he told Gus in a low voice, "but it acts like a wreck."

Gus turned a flash lamp on the clutch housing for a few seconds. "Thought so," he muttered; then he raised his voice: "Stan, get that large syringe and fill it with heavy oil." When Stan brought it, Gus inserted the syringe nozzle in the peephole in the clutch housing and squirted in the oil.

"Back in a minute," he told the Millers. He started the engine, threw in the clutch, backed out of the shop and down the driveway, and drove back without a jerk.

Henry Miller's mouth was gaping. "What—what did you do to it?" he asked.

"These old Silver Ghosts have leather-cone clutches that are as smooth as velvet—until the leather dries out," Gus explained. "Then they squeal and grab. If you remember to squirt about a pint of oil into your clutch once a month you won't have any trouble."

"I'll do it, all right," Henry agreed quickly.

"So will I," Stan put in, grinning widely. "Whenever I get hung up on a clutch job, I'll just squirt the clutch housing full."

"No, you won't," Gus told the grease monkey, gripping his arm hard. "Get that fool notion out of your head. Oil stops a leather-cone clutch from grabbing — but there are mighty few leather-cone clutches. Don't you go squirting oil on dry-disk clutches, or you'll make more trouble than you ever dreamed of!"

Stan was impressed by his seriousness. "O. K., boss, I'll remember," he promised.

"Now let's have a look at that carburetor." Gus raised the hood and examined it. "Yes, it's the old piston-plunger type that you can take apart and reassemble without a single tool. Watch what I do, Henry. The same thing should be done about every six weeks or as soon as your engine starts to miss and buck. You can do it as well as I can."

He unscrewed a part, removed a gasket, and then released the piston rod from the throttle linkage by withdrawing a pull pin, took out the piston rod, and held it up. It was covered with a gummy deposit.

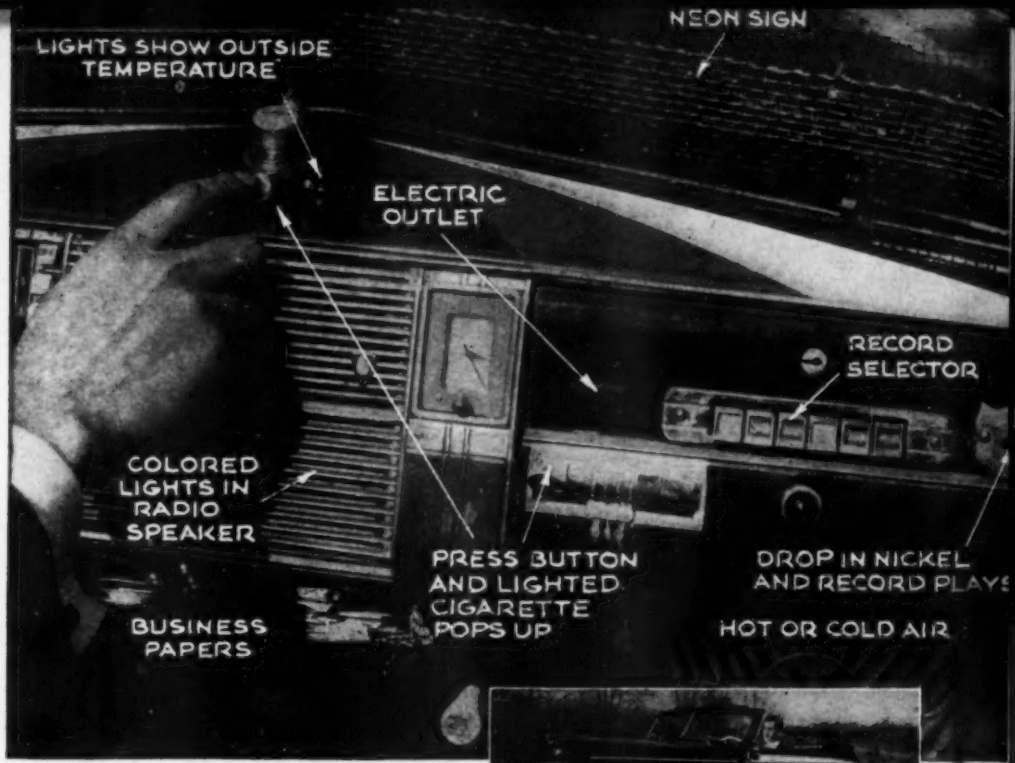
"The piston controls the air flow to the mixing bowl," he told Henry, "and when it gets gummed up like this it makes a Rolls Royce act like a jalopy on its last trip to the junkyard. This is the way to fix it." He soaked a piece of clean rag in clean gasoline and with it wiped the gummy stuff off the rod. Then he reinserted the piston rod, pushed back the pull pin, and returned the gasket to its place.

"That's the job," he said.

FIVE minutes later Mrs. Miller drove out of the shop with her old car running as smoothly as the last off the assembly line.

"I've always said," her husband remarked, "that when it comes to making a bus run right, there's nobody like Gus Wilson."

"But *precisely!*" Mrs. Miller agreed.



Photos by W. W. Morris

From the outside John Towber's car looks like any other, but inside you'll find an amazing array of gadgets. The photo above indicates a few of them.

ROLLING RADIO SHOP—
Last Word In Gadgetry

THIRSTY? Sleepy? Like music? Movies? Need a shave? John Towber's gadget car deluxe, shown above and also in color on page 120, supplies all these needs—and more. Except for home, there's no place like it. A 1941 convertible, it has *almost* everything.

Most important, of course, is the portable radio workshop in the rear seat, for that's Towber's mobile servicing unit. When night comes, he can go home or not—just as he chooses, for at the touch of a button the right front seat becomes a bed.

If he'd like a bedtime lullaby, there's either ice water from a faucet and music from a record player—but alas! there's no room for dancing!

a record player or a radio that has colored lights revolving in the speaker. If a burglar comes nosing around, a bell gives the alarm by night and the horn by day.

During the winter, a green light glows on the dash when the temperature outside is below freezing and a red one when it's above. A gasoline heater connected to a thermostat keeps the car temperature at 75 deg. automatically without the engine running. In summer, a pump forces cool air through the heater outlet from an icebox in the rear.

Smoking a cigarette is an astounding experience. When you touch a button, an ashtray and a cigarette (already lighted, by gum!) pop out of the dash. Five minutes later—when you're through—the tray automatically slides back.

Here's the real business end of the car—a radio repair shop in the back seat. Current for the many appliances is supplied by regular auto batteries.

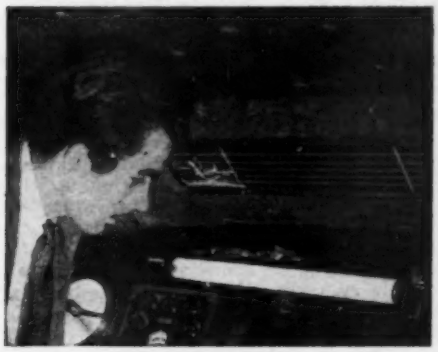
In the summer, cool air is forced through the heat outlet from an icebox in the luggage compartment.

Shaving on the run is no trick at all. Just plug an electric razor into a handy dashboard outlet.

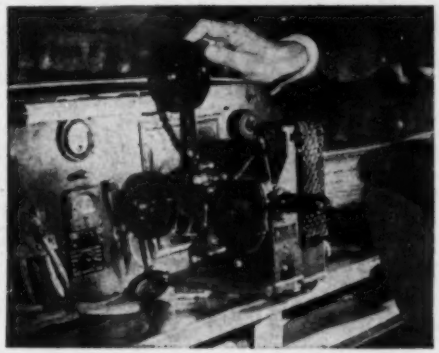
Air is put into the spare tire through tubing run from a fender valve. The trunk need not be opened.

Pick up a microphone and your voice can be heard outside even if all windows and doors are closed.

Under the hood you see: 1, the electric-eye unit; 2, its wires; 3, a motor that turns a color cylinder in the radio; 4, burglar-alarm unit; 5, cigarette-machine motor; 6, heater tank; 7, meter; 8, trouble light; 9, heater motor; 10, power system; 11, cool-air pipe; 12, burglar-alarm bell; 13, windshield-sign coil.



Stars glow romantically on the roof at night and a "Venetian blind" is painted on the rear window.



If you want to see a movie, a projector on the workbench throws pictures on a dashboard screen.

On the windshield a blue neon sign advertises the owner's radio business. The letters are 1" high.

When light from another car hits an electric eye under one headlight, the beams automatically drop.

Streamlined Scooter

DESIGNER'S DREAM CYCLE USES A
IT SPORTS A POLISHED ALUMINUM

Polished aluminum provides the motorcycle-scooter with a gleaming body that needs no paint finish.

A welded tubular-steel frame completely encloses the two wheels and motor. The tires are 6.00 by 6.

Under the seat is a 4-hp. engine coupled to an oil pump, and on the rear wheel is a hydraulic motor.

WITH an eye to the short-trip driver, quick-delivery services, and vacationists, Ray Russell, of Detroit, has designed and built an unconventional motor scooter. His engineering model has been clocked at 60 m.p.h., he says, and gets nearly 60 miles to a gallon of gasoline.

Wheels, motor, and driving mechanism are completely enclosed in a tubular-steel frame that gives protection in case of a spill. All are covered by a light-gauge aluminum body that can be lifted off in 10 minutes for servicing and repairs. When the scooter reaches production, the frame may be tough aluminum alloy.

The model shown in the accompanying photos has a 4-hp. engine under the seat connected by a flexible coupling to two oil pumps. A lever controls oil flow through a valve to one or both pumps to provide three speeds. On the rear wheel is a hydraulic motor. The tubing of the frame serves as an oil reservoir, and a 2-gal. gas tank behind the seat contains fuel for 100 miles.

Another model is planned with a chain drive and centrifugal clutch. Operation of either chain or hydraulic drive requires no gear shift. Starting is done simply by opening the throttle and stopping by closing the throttle and applying the brakes.

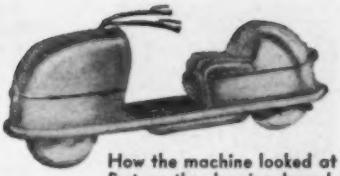
The two airplane-type wheels are extremely light magnesium die castings. They use four-ply tires 18" in diameter that absorb most of the road shock. Russell believes that tires of this type may eliminate the need for springs.

An engine-driven generator provides current for the horn, the single sealed-beam headlight, and the taillight. The instrument panel includes a speedometer. A windshield of clear plastic may be attached to the motorcycle handlebars by means of an aluminum frame.

With the motor mounted under the seat, plenty of leg room is provided under the aluminum hood. The rear deck has space for a luggage compartment or goods to be delivered, or it opens up to carry a passenger who will ride on a foam-rubber seat cushion like that in the driver's seat. No paint finish is planned, for the highly polished aluminum body itself adds to the appearance of the cycle.—CHARLES T. PEARSON.

HAS TURBINE DRIVE

4-HP. ENGINE AND GETS 60 M.P.H. BODY ON A LIGHT TUBULAR FRAME



How the machine looked at first on the drawing board.

A low center of gravity makes spills less likely.

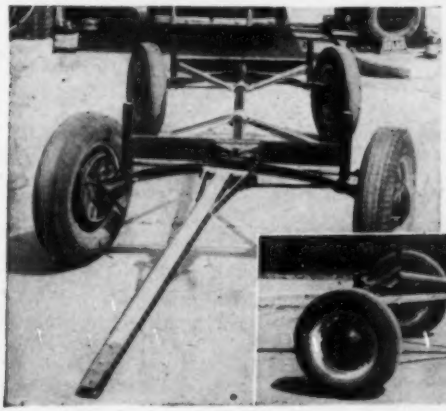
In the rear deck is luggage room or a rumble seat.

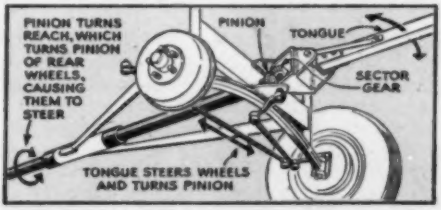
Four-Wheel Trailer for Farm and Highway Steers at Both Ends

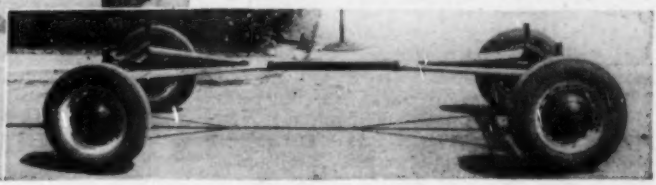
REAR wheels pivoted to follow the tracks of the front give this farm trailer the maneuverability of a two-wheeler. Its steering mechanism, which consists of a reach having a pinion at each end, was invented and patented by Dallas B. Avery, of Imlay City, Mich. The pinions engage the gear segment on each end of the draft mechanism, making it possible to use a tongue or drawbar at either end of the trailer. Both ends are identical.

Avery utilizes camber and caster on both pairs of wheels so that either end will steer properly when coupled to the tongue. The trailer can be turned in about half the radius of the conventional wagon without changing its load balance. It tracks as well as a two-wheeler and carries the load of a four-wheeler.

The trailer is of strong, light, all-steel welded construction. Reach and mechanism are at high points to give road clearance of some 18" between ground and axle or 24" to the top of the bolster.







THE HOME AND WORKSHOP

Rifle Telescope Sight

SHOOTING ACCURACY THAT WILL IS EASY WITH THIS 3½-POWER

By
WALTER E. BURTON

MAKING a telescope sight for a rifle is an excellent home-workshop project for the marksman who has a taste for fine lathework. With careful work he will turn out a rifle sight that will enable him to put a bullet in the 10-ring or to knock over a woodchuck far more often than would be possible with the use of iron sights.

Five lenses originally intended for a 3½-power Navy rifle sight were used for the sight illustrated. These and similar lenses are becoming increasingly available, but you may assemble your own lenses from various sources and, by careful positioning and testing, obtain good results. If possible, use achromatic lens elements. Because of greater freedom from color aberrations, they give better definition than simple lenses.

For the telescope sight shown, one objective lens is required, two are needed for the erector, and two for the eyepiece. The objective in the Navy set was .531" in diameter and had an approximately 48-mm. focal length; the erector lenses were .452" with 24.5-mm. focal lengths; and the eyepiece lenses were .807" and 52 mm. Most of the dimensions for the sight will depend, of course, on the diameters and focal lengths of the lenses used.

How the lenses form the image and convey it to the eye is indicated in Fig. 1. Lens spacing, as given by the distributor of the Navy lens set, is shown in Fig. 2. It's a good idea, however, to locate these positions by test, using these figures only as a general guide.

from Salvaged Lenses

SPELL DOOM TO "VARMINTS"

SIGHT FOR SMALL-BORE RIFLES

To do this, arrange the lenses in a cardboard or wood trough with modeling clay as an adhesive, and place the reticle (a pin stuck up in the trough) at the point where the objective lens brings to a sharp focus the image of a distant object. This point can be determined in a partially darkened room by placing a white card behind the lens and focusing on the object through a window. Place the erector next where it will form a sharp image of both the reticle and objective-lens image on a card held behind it. Finally, place the eyepiece lenses so they will magnify sharply the image of the reticle and object.

In making the telescope, you will need a length of steel tubing or bar stock for the smaller section of the housing shown in Fig. 3, larger tubing or bar stock for the eyepiece end, and brass tubing or bar from which to machine the three lens mounts and the reticle tube. The ring holding the reticle-adjusting screws is machined from steel, as shown in the inset in Fig. 3, as are also

HOW A TELESCOPE SIGHT WORKS

Light from the object on which the sight is directed passes through the objective lens and is brought to a focus a short distance down the tube. Here a real image is formed, as could be shown by placing a ground glass in this plane. Cross hairs located at this point are superimposed on the image. Since the image is inverted, and it is a bit disconcerting to aim at an upside-down skunk or woodchuck, an erector lens is used to reinvert the image. The function of the eyepiece lens or lenses is to magnify the image, now right side up and provided with cross hairs.

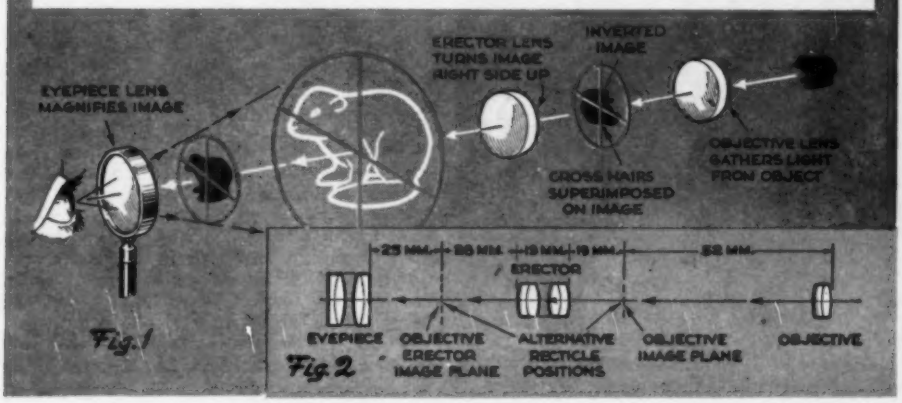
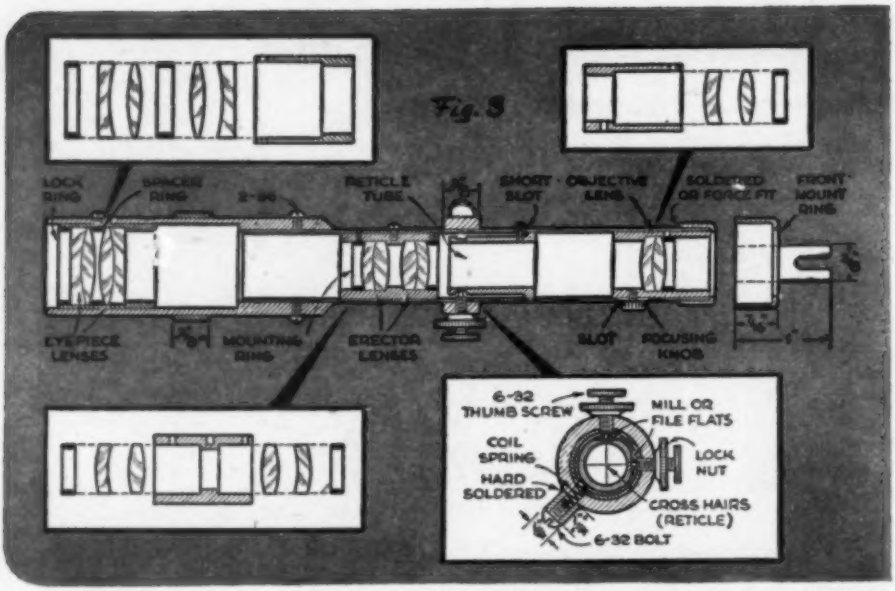


Fig. 1

Fig. 2

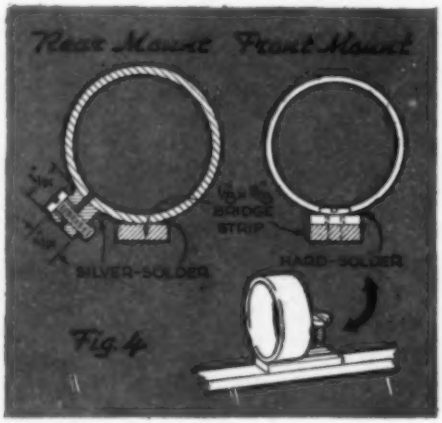


Distances between lens mounts depend on the focal lengths of the lenses used, and diameters of the tubes on lens diameters. Achromatic lens elements consist of positive and negative lenses cemented together.

the two mounting rings, front and rear, shown in Fig. 4.

Lens mounts are brass tubes into which the lens elements can be slipped with an easy but not too loose fit. They are held by spacing and retaining rings. It will usually be found convenient to machine the mounting tubes to fit the inside diameters of the telescope housing, but the housing can be bored to fit the mounts as well.

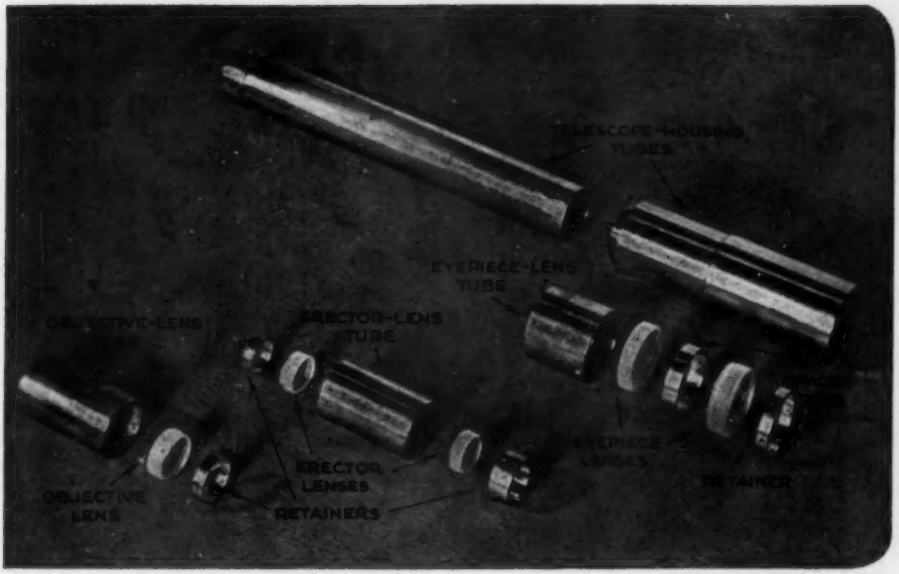
Two methods of machining the mounts to take two lenses are shown, one for the eyepiece and the other for the erector lenses. In one instance a single recess is bored for both lenses, and a spacing ring is made to hold them apart the required distance. A lock ring holds both elements and the spacer in position and may be secured by two or three small setscrews. The second method is to bore a lens recess at each end of the mount, leaving enough intervening metal to give the necessary lens spacing.



Check the lens diameters with a micrometer and bore the mounts about .001" larger so the lenses will slide easily into the recesses. If they rattle too much, the fit may be improved with strips of cellulose film or with lacquer applied to the recesses and allowed to dry before the lenses are inserted.

All the lens mounts should be of an outside diameter that permits them to be pushed without too much resistance into the housing. The eyepiece and erector-lens mounts are fastened in the barrel by 2-56 or similar screws, and the objective-lens mount is held by a knurled-head screw running through a longitudinal slot in the telescope tube. This slot permits moving of the lens for focusing, and its position and length should be found by trial.

Paint the inside surfaces of the lens mounts dull black to prevent reflection. Optical lacquer, blackboard paint, and powdered



Disassembled view of the lenses, spacing rings, retaining rings, and mounts in the telescope sight. The telescope housing is made up of two steel tubes, one of which slides in the other to permit adjustment.

drop black mixed in thinned shellac or brushing lacquer are all satisfactory.

For the tube illustrated, the outside diameter of the forward section was ¾" and the length about 5"; the rear section had an outside diameter of 1" and a length of 3"; and the total length assembled was 7". The two sections are joined with a push fit and are held by two setscrews. In focusing the eyepiece, it is an easy matter to loosen the screws and move the sections in or out. Nonreflecting paint of the kind used in the lens mounts should also be applied to the inside areas not occupied by lens mounts.

The reticle tube is machined to .050" or .100" less than the inside diameter of the barrel except for a 1/16" shoulder at the front end. This ought to cover sufficient elevation and windage at 100 yd. The larger rim should have a crowned face and be a snug but not tight fit inside the barrel. It serves as a kind of fulcrum when the cross-hair end of the tube is moved sideways or up and down.

Two knurled adjusting screws equipped with lock nuts press against the reticle tube near the smaller end, their axes at right angles to each other, as shown in the inset in Fig. 3. A stiff coil spring presses against the tube at a point 135 deg. from the screws. The tips of the screws are turned down to about .050" and carefully rounded and smoothed; and a groove is machined around the tube and two flats are milled or filed in it at right angles to each other. These flats are important, for they permit windage to be adjusted without disturbing the elevation, and vice versa. A little watch oil or graphite on the flats will help prevent sticking. Nonreflecting paint is also applied on the inside of this tube.

Tungsten wire of the size used in 60-watt lamps (.0018" diameter) was used for the cross hairs in the sight shown. This may be a bit heavy for target work, and strands of spider web can be substituted. The cross hairs should be carefully positioned so they will be in line with the adjustment screws. With a jeweler's saw, cut shallow notches about the depth of the blade in the smaller end of the reticle tube, making them as near 90 deg. apart as possible. The cross hairs may then be set in with shellac, Canada balsam, or quick-drying household cement. Stretch them taut.

Endwise shift is prevented by the reticle-tube groove into which the machined ends of the adjustment screws fit. The groove therefore should be but slightly more than .050" wide. To prevent rotation, a small screw runs through the telescope wall into a hole in the reticle tube. One or the other holes should be loose enough to permit the tube to tilt. The position of the reticle for sharp-

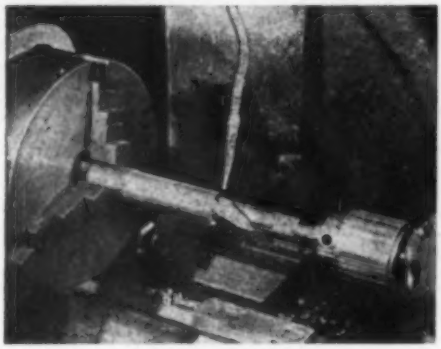
est focus is determined approximately by trial; then final adjustment is made by moving the eyepiece-lens system.

In installing the telescope sight, run the large end into the rear mounting ring first, removing the eyepiece-mount bolt temporarily if it is not flush. The front mounting ring, or open cap, is then slipped over the front end, and the assembly is slid forward until the slot in the front-ring lug is beneath the bolthead. This bolt and the one that clamps the larger ring around the tube (Fig. 4) are tightened to hold the telescope in place. To rotate the telescope in its mounts, first loosen the rear-ring bolt. The front ring should fit just snugly enough to prevent side play.

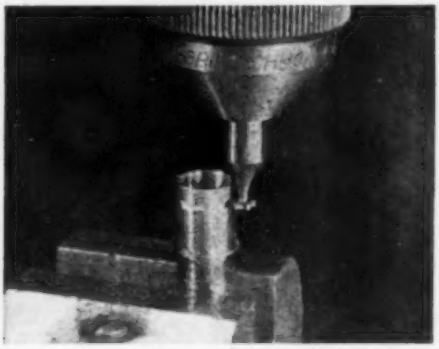
Blue all steel parts, including boltheads, either with a chemical that can be obtained from a gun-supply dealer or by heating to make an oxidized finish. In the latter case, polish the metal bright, heat slowly and evenly by torch, gas burner, or furnace until it turns deep blue, let it cool, and apply a light coating of oil, which will darken the color appreciably. If the color disappears because of overheating, simply cool, repolish, and try again.

In testing the telescope sight, set the cross hairs in the central position and focus the objective lens until an image at 100 yd. is sharp. If the cross hairs are not also sharp, refocus the eyepiece and reset the objective lens, too, if necessary. Clamp the gun and move from side to side while peering through the telescope. If the lenses are focused properly, image and cross hairs will appear to move together.

Then fire a test shot and note where the bullet strikes. If it is too far off the target, raise one end of the mount by inserting a washer or shim under the bridge strip or move one end of the bridge sideways, filing the bolt hole to form a slot, if necessary. When good grouping of shots cannot be obtained, check for a loose end or other part or to see if the reticle is in proper focus and tightly held by spring and screws.

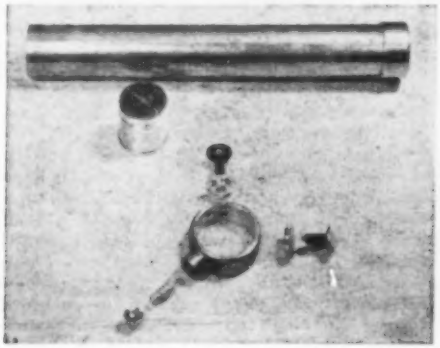


Cold-rolled steel bar stock is bored in the lathe when making one of the telescope-housing tubes.

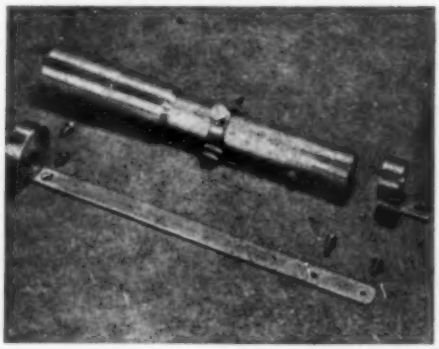


Milling flat areas on the reticle tube. Two flats are required for windage and elevation adjustment.

Below, an exploded view of the reticle-adjusting controls. Cross hairs can be seen on the tube.



Here are the telescope and mounting bridge. The bridge is held to the rifle barrel with two bolts.

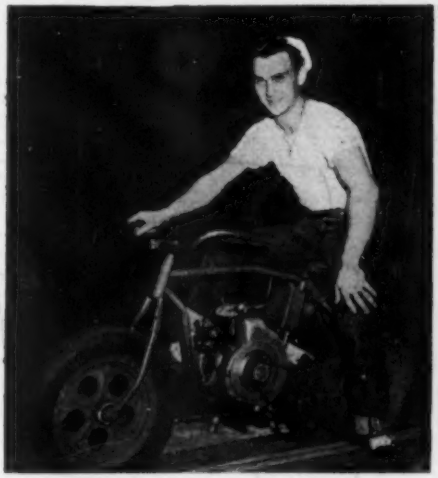


CRAFTSMEN AT WORK

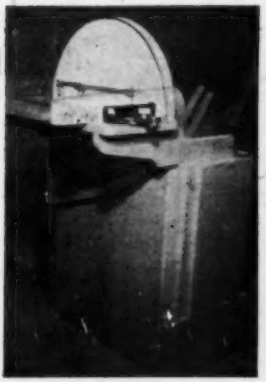
FOR A REAL KITCHEN CLOCK, what could be better than a frying-pan case and a cook-spoon pendulum? This is one of a collection of 75 clocks in the Hickory, N. C., home of James L. Cilley, who for 45 years has been hunting the unusual in timepieces. Clocks adorn walls and mantels in every room. He keeps them in good running order himself.

MONGREL MOTORCYCLES are favorite projects of many mechanics, but the hybrid shown below was crossbred over a 15,000-mile search of half a dozen Pacific islands. Coast Guardsman Gerald C. Grant, of Oakland, Calif., picked up its Japanese outboard engine on New Guinea, a sprocket and two chains from a Jap motorcycle on Mindanao, its cut-down bicycle frame from his ship's hold, and the wheels from a Signal Corps wire cart. He assembled the machine between watches and delivering invasion supplies on Biak, Luzon, Zamboanga, and Borneo.

Having neither clutch nor brake, it's strictly a suicide job, but it will do 40 miles an hour and get 100 miles from a gallon of gas.

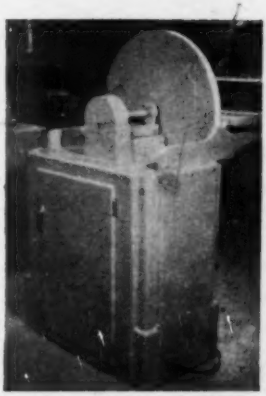


GI HANDICRAFT is never more inventive than when materials are improvised. This African head won second prize at a recent show by the Second Service Command at the Metropolitan Museum of Art in New York. It was made by Sgt. Winslow Anderson, of Plymouth, Mass., from a currying brush, covers of tins, snap hooks, spring wire, and odd pieces of brass.



SMOOTH WORK went into this disk sander, and smooth work comes off it in the Angola, Ind., home workshop of Russell Jackson, who designed and built the machine for a total cost of $10.

A ¼-h.p. motor in the 15" by 27" by 32" cabinet pulls a 24" plywood wheel to which is glued a disk of medium-fine sandpaper. The motor is mounted on an adjustable bracket to take up belt tension and is accessible through the cabinet door. It runs the wheel at 1,750 r.p.m. Dust is trapped in a built-in chute and delivered outside. The table is grooved for a miter gauge.

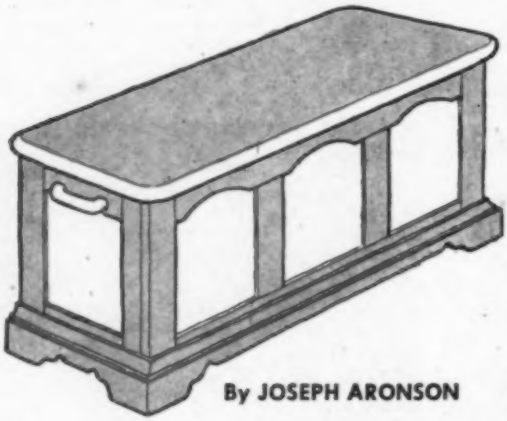


Pennsylvania Dutch Hope Chest

"BRIDES' CHESTS" were among the outstanding productions of the Pennsylvania Dutch farmer-craftsmen who colonized parts of Pennsylvania in the early 1700's. They brought with them a homely, substantial carpenter skill that echoed the medieval German tradition, and they embellished their creations with fanciful painting, as illustrated in full color on page 120.

This chest follows old models in both design and construction. The panel effect has an arched suggestion reminiscent of old stone architectural forms and functionally ideal for strength and lightness. Sides, back, floor, and front are each made as a complete panel of ¼" plywood rabbeted into a joined frame. The panels are then put together to form a box, and the finish base and molding trim are added.

A hinged top is made of whitewood board with molded edges, cleated with two beveled cleats, and hinged to the top of the back. All corners and edges should be sanded quite round to give a pleasant worn effect. Full directions for decorating will appear in the May issue.

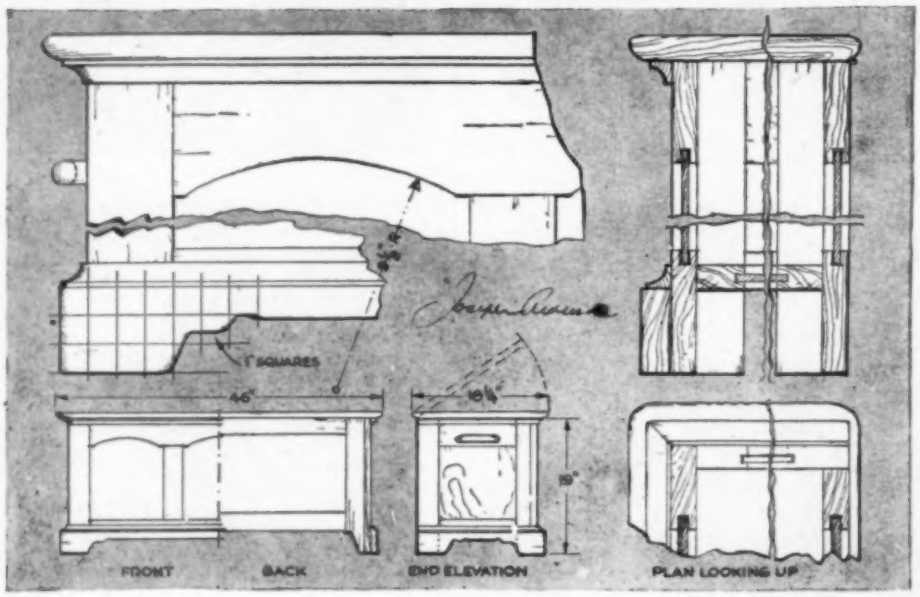


By JOSEPH ARONSON

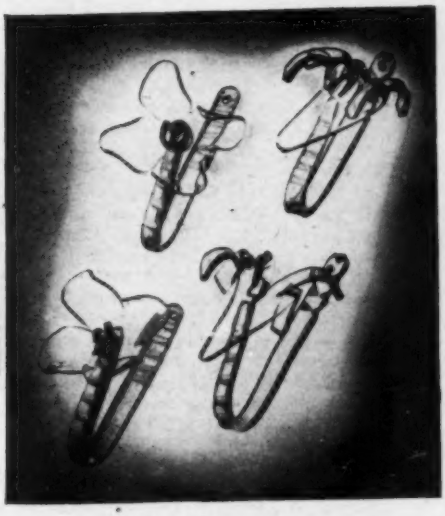
LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
1	Top	¾	18½	46
2	" cleats	¾	3⅛	14¼
4	Side uprights	¾	2¼	19
2	" bottom rails	¾	2⅛	12½
2	" top "	¾	5	12½
2	" panels (plywood)	¼	10	10½
2	Front end uprights	¾	3	19
2	" middle "	¾	2¾	10
1	" bottom rail	¾	2⅛	37½
1	" top "	¾	5	37½
3	" panels (plywood)	¼	11	11½
2	Back uprights	¾	2⅛	19
1	" bottom rail	¾	2⅛	37½
1	" top "	¾	3½	37½
1	" panel (plywood)	¼	18⅞	37½
2	Floor sections	¾	1⅞	41⅜
3	" sections	¾	2¼	12⅛
2	" panels (plywood)	¼	12⅛	17⅞
1	Base front	¾	3	44⅜
2	" sides	¾	3	16⅞
4	Cove trim	¾	¾	16¾
2	" "	¾	¾	44⅜
2	Handles	1⅛	1¼	6

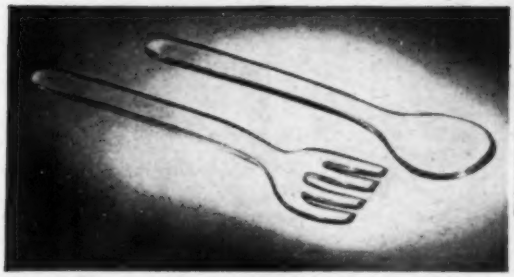
Miscellaneous: 2 cabinet hinges, 1½ by 1½; 1 stop chain.
Note: All dimensions are given in inches.

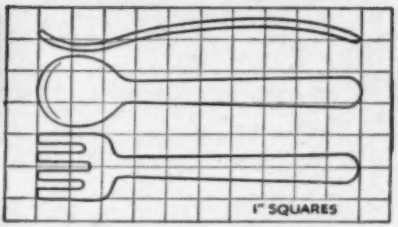


THREE CRAFT PROJECTS IN CLEAR PLASTIC



Small plastic frames for color snapshots are made in one piece by heating and bending. At right, curtain tiebacks, sawed out, bent, and cemented.





Salad fork and spoon sawed and shaped from plastic. Both are bent to the profile shown.

BOTH decorative and utilitarian articles can be made for the home from small pieces of clear plastic. Such scraps may be left over from sheets obtained from a craftwork-supply house for making larger projects, or windshield trimmings and the like may sometimes even be had for the asking at an airplane factory.

Stock 1/16" to ¼" thick is suitable for the curtain tiebacks shown at right above. A 2 7/16" by 4⅝" blank ⅛" thick makes a frame for a popular-size color print, which is cemented on. The salad set is ¼" stock.

All pieces are made in the same general way. First, a piece is sawed to shape; then all edges are filed and sanded, finishing with the finest sandpaper, and the piece is polished by buffing with tripoli or some other fine compound. Shaping follows, the piece first being heated slowly to about 250 deg. F. (an ordinary kitchen oven will do) and then bent in the gloved hands while still hot. It will cool in a minute or two, after which it will hold its shape. Wipe with alcohol and polish with a dry, soft cloth.

The bowl of the spoon, the handles, and the bend in the frame are shaped that way. Drill the flower centers and file the decorative notches in the clips before shaping; afterwards cement the flowers to the clips and insert colored radio-hookup wire in the holes for stamens. Use model-airplane cement or one made of plastic chips and acetone.—FLORENCE DRAKE.

Midget Steam Tug

. . . FOR DUCKPOND NAVIGATORS

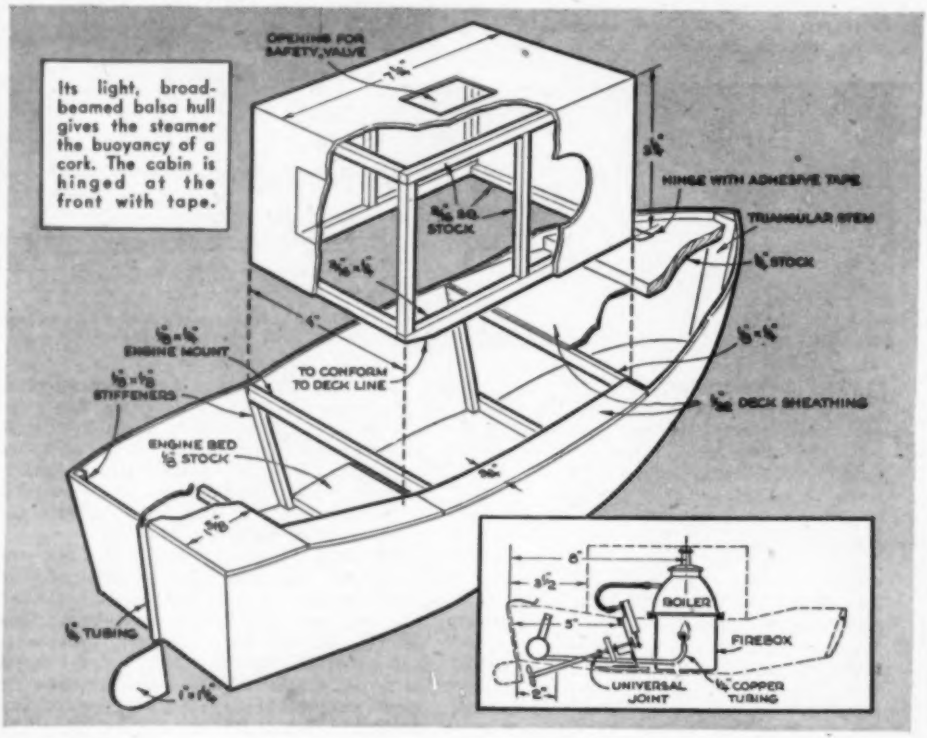
By ROY L. CLOUGH, JR.

DRIVEN by a spunky little engine of the oscillating-cylinder type, this snappy steam tug kicks up quite a wake in the neighborhood duckpond. Its boiler is a large oilcan, the piston and cylinder of its engine were made from a pair of fishing-rod ferrules, and one filling of water and alcohol keeps it going for more than an hour.

Sturdy yet light, the little craft floats high and is steady and seaworthy even in comparatively rough water. The hull is 1/16" medium-hard sheet balsa and the cabin is light cardboard on a balsa framework.

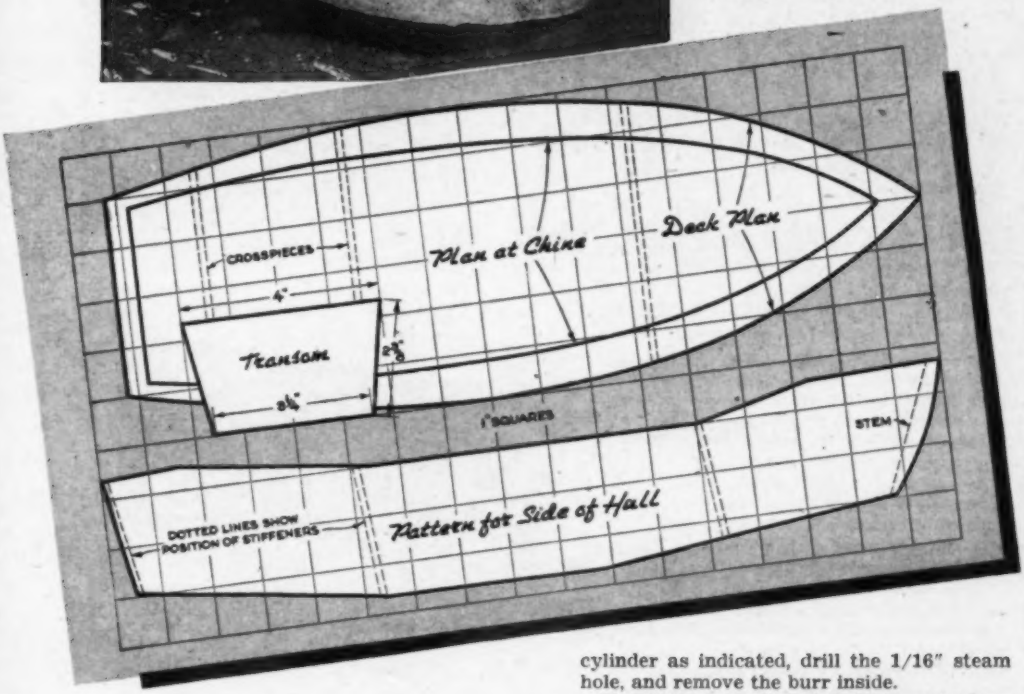
A good soaking in hot water will make it easier to bend the sides of the hull. When they are thoroughly wet, put all stiffeners and crosspieces in place temporarily with pins, draw the bows together against the triangular stem, secure with rubber bands, and allow to dry before assembling permanently by the liberal use of pins and model-airplane cement. Also use plenty of cement in applying the bottom and transom, running it well into all joints and inside corners. Cut the raised triangular section of the foredeck from ¼" stock and the rest of the deck sheathing from 1/32" sheet balsa. The stack is a piece of mailing tube, the rudder tin-can stock soldered to a wire that turns in tubing cemented to the transom.

Finish the interior of the hull and the decking with three coats of model-airplane dope, and cover the outside with model tissue or silk, stretched and bonded to the wood with half a dozen coats of dope. This will make the vessel entirely seaworthy.



Full Speed Ahead and Beware the Bullfrogs!

Its name came from the boiler (spell it backwards). The whistle is a rifle cartridge, life preservers are mints.



Fishing-rod ferrules about 5/16" in diameter are needed for the engine. With a bit of very fine valve-grinding compound, lap two such telescoping ferrules together until a smooth sliding fit without shake is obtained. Since the ferrules are thin, cut them to length by filing around instead of sawing.

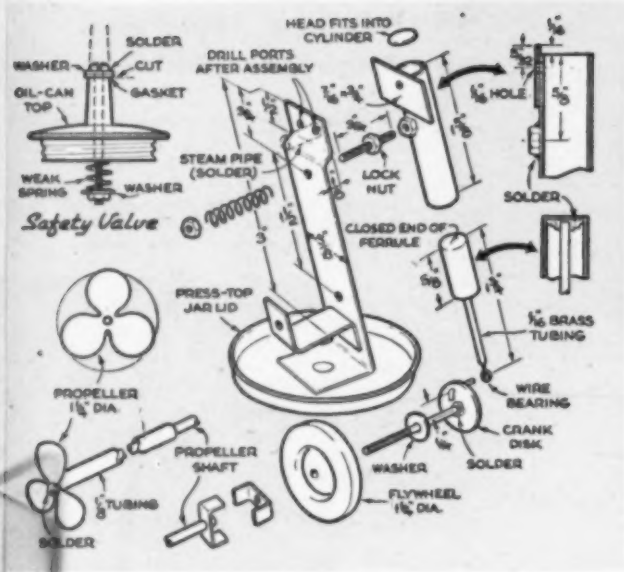
The connecting rod is 1/16" tubing such as is used in mechanical pencils. It is held in place by setting it in some molten solder inside the piston. Bend a bit of wire for the connecting-rod bearing, tin it liberally, insert in the tube, and heat.

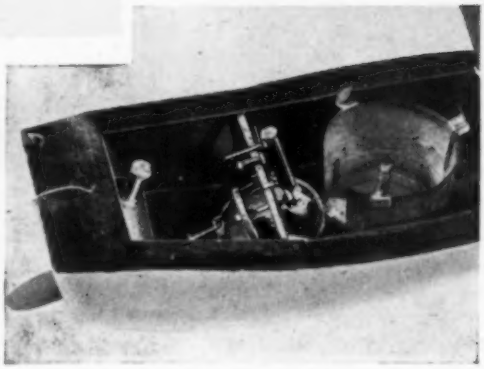
Cut the cylinder plate from 1/32" sheet brass and polish by rubbing lightly back and forth on a fine file. Make it as smooth as possible, for this is the sliding face of the oscillating valve. Solder the plate to the cylinder as indicated, drill the 1/16" steam hole, and remove the burr inside.

Now take a small nut that fits a ¾" long headless screw and solder it to the cylinder below the plate. This forms the cylinder pivot mount. The pivot is secured in the soldered nut with a lock nut, and a spring and nut are placed on the end that projects through the engine upright.

Bend this upright from a strip of brass, being careful to form the ⅛" offset. Then drill the holes for the cylinder pivot and the main bearing, but leave the steam ports until later.

You can build up a crankshaft from a bicycle spoke or use a model-airplane thrust shaft and bearing. In the latter case, disassemble the unit by melting out the solder. Then solder the bearing tube into the engine upright, solder the round propeller plate in reverse position to the unthreaded end of the shaft, and in one of the holes on the





Lugs are bent in the top edge of the tin-can firebox (at far right) to support the boiler, and alcohol flows to the burner from a tank in the stern. After pressure builds up, the engine is started by flicking the flywheel.

plate solder a short piece of wire bent at right angles and offset ¼" from the crankshaft. Clamp the flywheel and universal joint between nuts.

If a shaft is made from a bicycle spoke, a crank may be bent at the end, and the flywheel and universal joint may be soldered fast. In this case, you will need the outboard bearing shown above.

A flywheel may be cast in a plaster mold from Babbitt or type metal by using a wood model-plane wheel for a pattern. Pieces of brass are bent to provide the universal joint. In installing the propeller assembly, keep the top of the shaft tube above the waterline.

Assemble the engine and rotate the flywheel to make sure everything works freely. With a scribe placed through the steam hole in the cylinder, mark on the engine upright the points of maximum travel of the cylinder both to the right and left. At these points drill 1/16" holes for the intake and exhaust ports, polish the valve face, and solder a steam pipe to one of the holes. A brass disk soldered into the cylinder head completes the engine. Lubricate with castor oil.

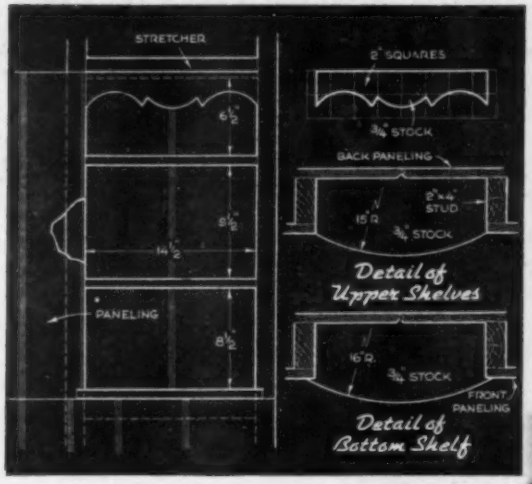
Mount the engine in a jar-lid drip pan with a small bolt and nut. Bend the engine upright sufficiently to bring the crankshaft into line with the propeller shaft, and then cement the pan to the balsa engine bed. Also wedge the engine upright between two pieces of balsa cemented to the crosspiece.

Solder a piece of tubing into the oilcan boiler for a steam line and either cut off and seal the spout or install a safety valve, as shown in the drawing. A gasket under the oilcan top is essential.

Cement a tin-can firebox to the bottom of the boat after cutting and bending flanges on the top edge to hold the boiler. Connect the engine and boiler with neoprene tubing, which is sold by model supply houses for gas-engine fuel lines.

The alcohol tank is made from tin-can metal. Into it solder a piece of ¼" copper tubing long enough to reach the center of the firebox and rise *above the fuel level* in the tank. Insert about 3" of wicking.

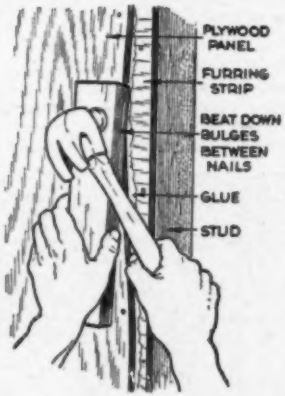
SHELVES SET BETWEEN STUDS ORNAMENT PANELED WALL



THESE narrow recessed shelves provide an attractive setting for dishes, knick-knacks, or books. They occupy the space between studs of an interior wall and are used to best advantage when both sides of the wall are to be paneled. However, if the adjoining room is to be plastered on lath, an appropriate piece of thin plywood can be set in for the back, or if plasterboard is to be used there, wallpaper, cloth, or paint is suitable for the background. The studs themselves, if they can be finished smooth enough, serve for the sides of the case, or they can be faced with thin plywood pieces.

First frame the shelf space by inserting two stretchers to bridge the gap between studs and mark the top and bottom of the case. They may be at any agreeable height and any distance apart to accommodate three, four, or even five shelves. Then nail the shelves in through the studs, resting the bottom shelf on the lower stretcher. The scroll is attached to the upper stretcher with finishing nails plugged over with wood putty, and the paneling is brought up all around the opening.—NORBERT ENGELS.

NAILING AND GLUING PLYWOOD [WOODWORKING]



Interior

Plywood	T.	Nails (casing or finishing) Unglued	Glued
Hardwood	¼"	6 d.	4 d.
Douglas fir	¼"	4 d.	4 d.
" "	⅜"	6 d.	6 d.
" "	½"	8 d.	8 d.

Exterior

Plywood	T.	Nails (common)
Sheathing	5/16"	6 d. coated
"	½"	6 d.
"	⅝"	8 d.
Waterproof Douglas fir	⅜"	6 d.
" "	½"	8 d.

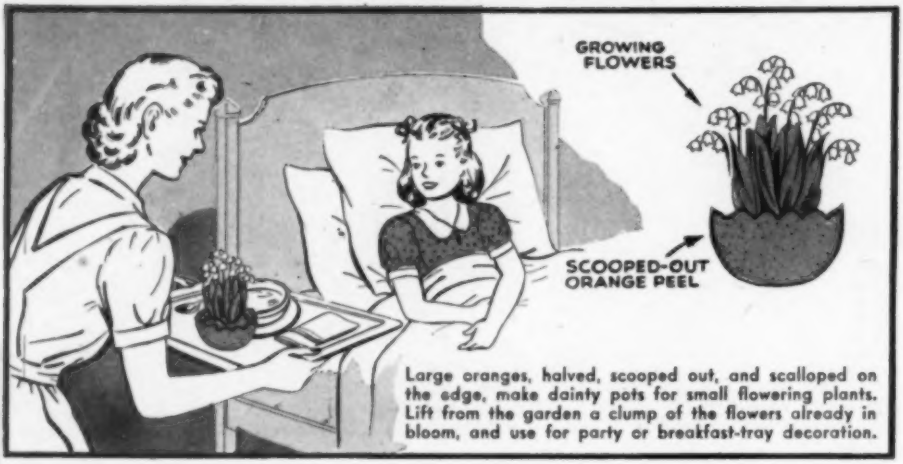
Unglued plywood should be nailed at 12" intervals on intermediate studs and at 6" around the edges. Nail glued plywood enough to hold until the glue dries. To permit shifting of the edges as cupping is flattened out, nail at the center and work toward edges and corners.

Use heavy-mixture casein glue brushed in thick ribbons on the furring strips and press and slide the plywood panels into position. Glue should ooze full-length along the edges as they are nailed. If the plywood bulges between nails, beat it flat with a block and hammer.

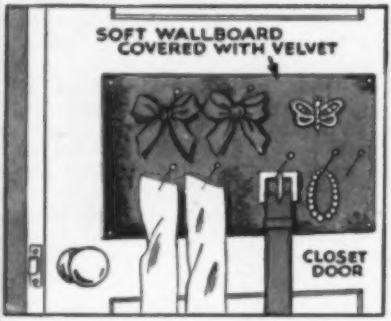
With butt joints for papering or painting, allow the squeezed-out glue to dry and sand flush with block-backed sandpaper. For bright (natural) or stained finishes, remove the glue immediately with a damp cloth to prevent staining.

POPULAR SCIENCE MONTHLY SHOP DATA

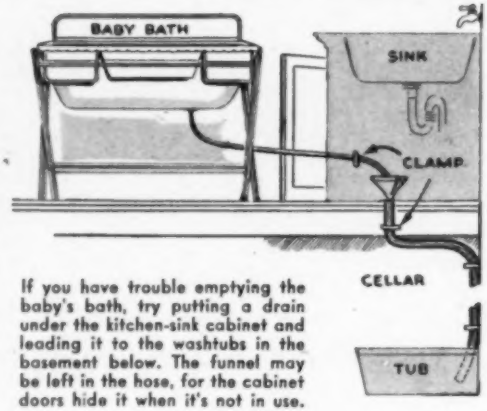
KEEPING THE HOME



Large oranges, halved, scooped out, and scalloped on the edge, make dainty pots for small flowering plants. Lift from the garden a clump of the flowers already in bloom, and use for party or breakfast-tray decoration.



Pins, brooches, ribbons, belts, and the like can be kept conveniently at hand on a pin-up board like that shown above. Make the board larger than the door panel and tack it fast.

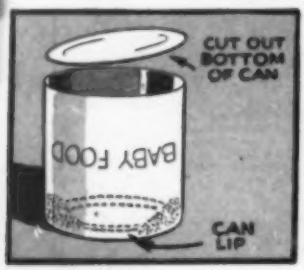


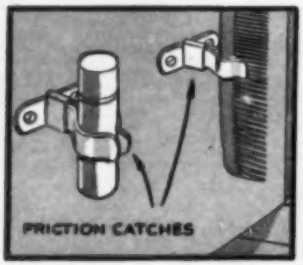
If you have trouble emptying the baby's bath, try putting a drain under the kitchen-sink cabinet and leading it to the washtubs in the basement below. The funnel may be left in the hose, for the cabinet doors hide it when it's not in use.

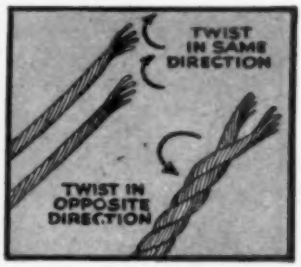
Baby-food tins with push-on tops will yield that last bit clinging to the can lip if you cut out the bottom. Test the can opener first to see it does not leave slivers.

Spring cupboard-door catches may be used for many other purposes. In a medicine cabinet or vanity drawer, a large one will hold a lipstick and a small one a comb.

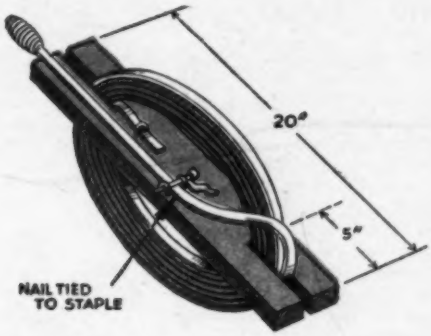
Strong cord can be made of light string in case of need. Separate strands into equal groups, twist clockwise, and then twist these groups counterclockwise into one.





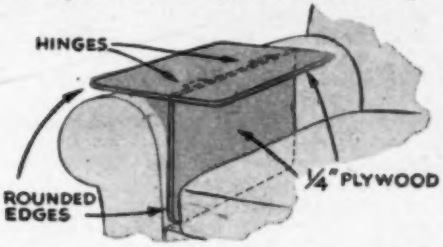


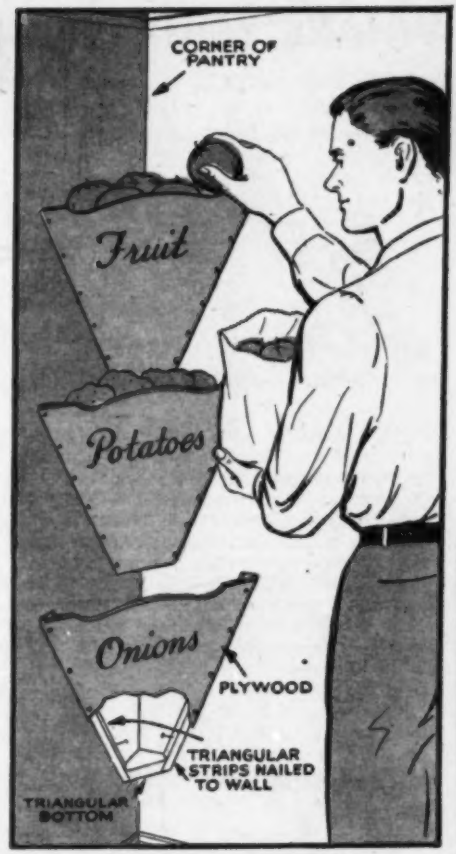
SHIPSHAPE



Its tail stapled securely to a reel, a plumber's snake can be wound neatly in the grooves and its head end fastened by a nail between two staples. When put to use, as much of the snake as needed is unwound and the nail reinserted in the staples.

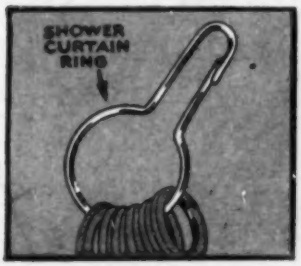
A pair of hinged boards that slips down beside the cushion of an easy chair and rests on the arm, as shown below, forms a convenient writing desk for answering letters or taking notes while reading.



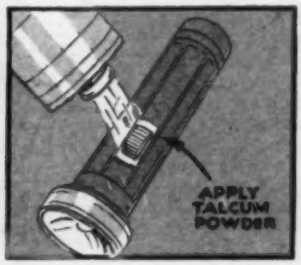


Triangular vegetable and fruit bins are easily put up in a corner of a small kitchen or pantry, where they take little room. Saw the top edge to a nice curve and sand smooth. The finish may be natural or enamel, and lettering or decals can be added.

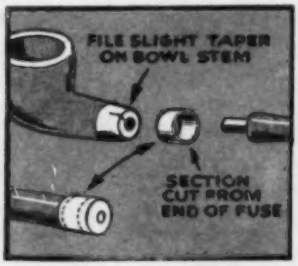
Garden-hose and other washers are kept sorted on metal spring-type shower-curtain rings. The rings may be suspended on a belt loop in use and stored on a peg.



Sticking switches on plastic or metal flashlights will operate smoothly if dusted with a little talcum powder, and the powder won't soil the hands or gloves.



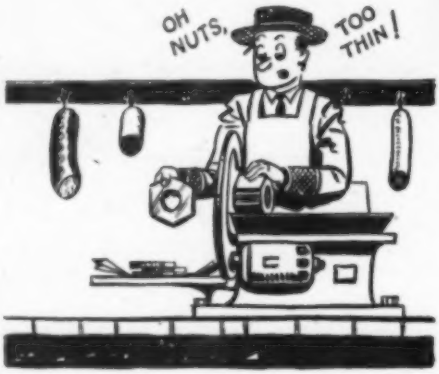
Narrow bands cut from the brass ends of cartridge fuses fit most pipe stems. The little ferrules will repair a split or compress a loose shank tightly on the stem.



WHAT'S YOUR INGENUITY QUOTIENT?

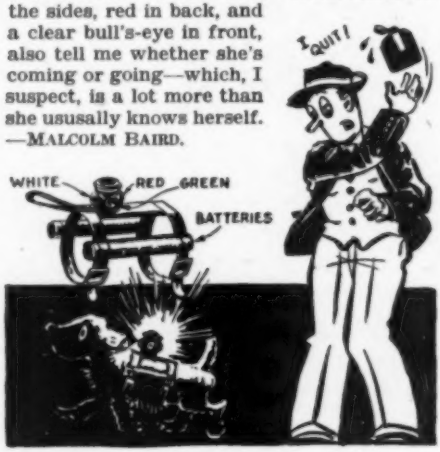
Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.

IT'S NO BULL of mine that stands quietly in his pasture. Whether peacefully munching his fodder, or angrily chasing me out of his domain, the frolicsome beast always managed to snarl his tether. Not to be outwitted by a heifer's husband, I drove an old junk-wagon axle into the ground and tied a rope to the wheel. In this free-wheeling farm yard, exercise still comes in circles, but it's only the bull that has reached the end of his rope.—JOSEPH J. FUSIK.

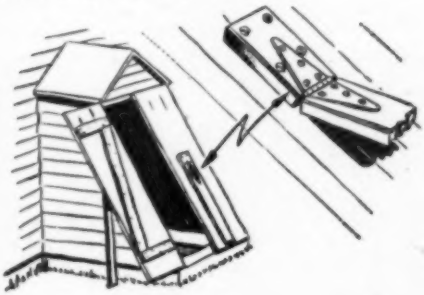


NO MATTER HOW THIN YOU SLICE IT, it's still a nut. When one worked loose and caused a wheel to drop off my portable air compressor, I ransacked my shop in a fruitless search for a replacement of the same size. But who has ever found the right part in an emergency? Certainly not me! Nutty problems aren't hard to crack, however. I took off another wheel in order to obtain a similar nut of the correct thread and diameter. Then I grabbed up a hacksaw, and—you guessed the rest—sawed the thing in half.—ROBERT F. APPLETON.

RUNNING LIGHTS ON MY PUP have saved me a lot of running. Well behaved most of the time, she sometimes gets a yen for solitude and ambles off into the night. Battery-operated lights, housed in the turretlike harness, now keep me posted on her whereabouts and direction. Green lenses at the sides, red in back, and a clear bull's-eye in front, also tell me whether she's coming or going—which, I suspect, is a lot more than she ususally knows herself. —MALCOLM BAIRD.



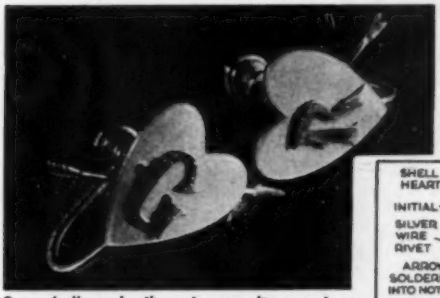
TRIMMING THE LAWN is a job I dislike, especially since I was faced with the weekly chore of hand-clipping the grass around the posts supporting the cellar doors. Remembering an old saw that headwork's better than handwork—or at least easier—I uprooted the posts and mowed the lawn without stopping. Then I screwed a length of wood midway to each door and hinged to it a block of the same stock. When a door is opened, the post falls into position, but drops back out of the way again when the door is closed.—ARTHUR BATES.



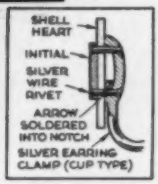
Mirror on Table Beside Typewriter Serves as End-of-Page Indicator

YOUR typewriter bell signals the end of a line, but it is difficult to tell when you are on the last line of a page. If your typewriter is the kind that has no shield covering all the lower parts of the platen, a small mirror laid beside it on the right-hand side of the typewriter table will reflect the bottom of the platen and show when the end of the paper is reached. The mirror can be held in place with pieces of adhesive tape.—O. D. COWLES.

Earrings of Iridescent Sea Shell Are Ornamented with Silver Wire



Sea shell and silver in novelty earrings. How they are made is shown at the right.



NOVELTY earrings such as the initialed heart-and-arrow pair shown at left are made of ordinary sea shell and of silver wire from a jeweler's supply house.

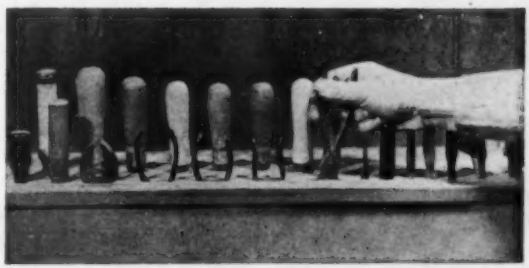
File the shell to shape, sand it smooth, and buff to a high polish. The initials and arrows are shaped from flattened silver wire and attached to the shell with silver-wire rivets through holes made with a No. 73 drill. First, however, the arrow or similar backing is soldered in a notch in the clamp, also a supply-house item. The rivets are peened and polished flush with the surface.—E. G.

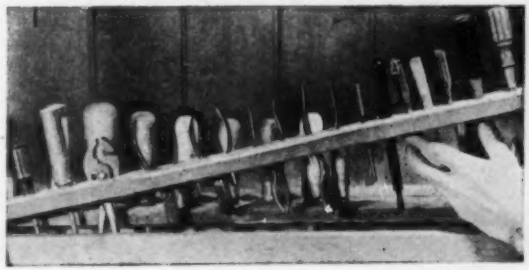
Sectionalized Rack Holds Dozens of Small Tools

FILES, chisels, screwdrivers, and the like accumulated over a period of years are often too numerous to keep neatly racked on the workbench. Here is a sectionalized tool rack that will take care of dozens and also provide room for adding new tools as they are acquired.

Holes and slots to hold the tools are put in 2½" by 24" strips of shelving, and the shelving is placed three rows deep on a frame between the back of the workbench and the wall.

When certain tools are needed on a job more frequently than others, their rack is simply shifted to the front. Although at first all the handles may look alike, you will soon be able to select the tool you want every time without hesitation.—D. J. BACHNER.





Cabinetmaking Problems

By EDWIN M. LOVE

GOOD design and manual skill are not the only requisites of successful cabinetmaking. Proper selection of materials and a logical plan of working, not to mention ingenuity in overcoming mistakes and in removing defects, are equally as essential.

Careful choice of materials is a prime consideration. Broad surfaces, such as the top and ends of the buffet shown in Figs. 1 and 6, shrink and swell excessively if made of solid lumber. Such parts should be of plywood, though narrow members in the frame need not be. Obviously parts that are to be carved or molded demand solid stock.

For adjacent parts, select plywood having suitable grain patterns. The plywood sheet should be large enough to allow cutting of parts with matched patterns properly centered or

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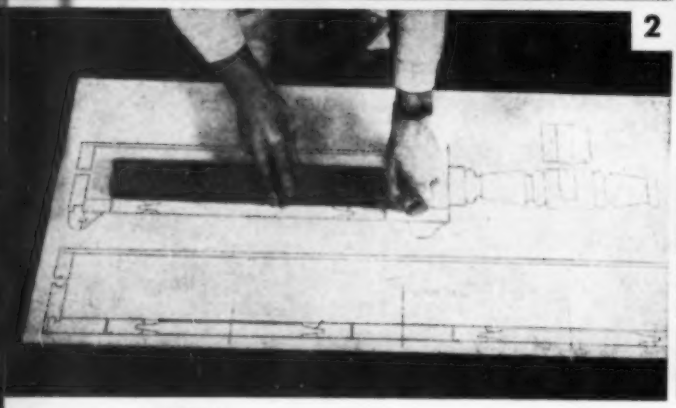
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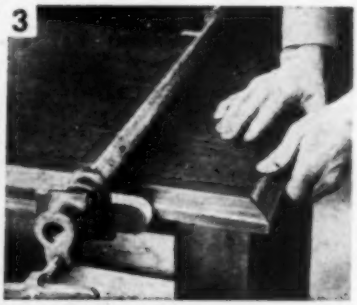
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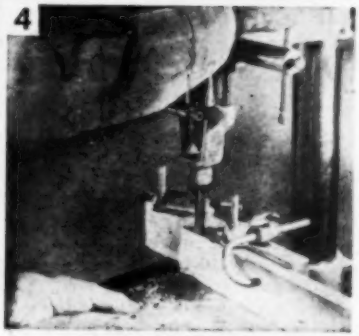
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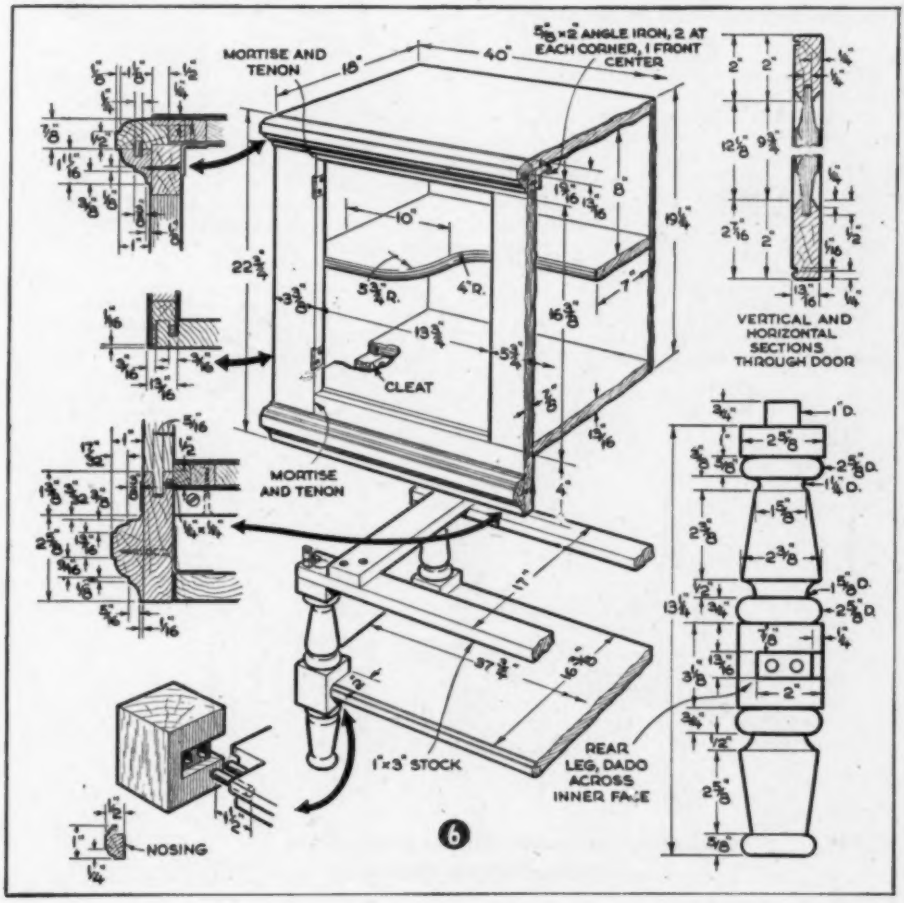
5

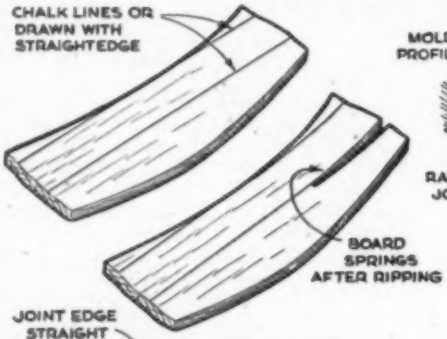
and Their Solution

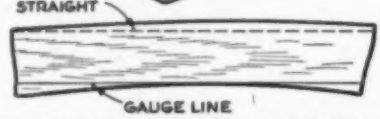
otherwise placed. A sheet that is warped but otherwise desirable can be used in "carcass" (body) building where the braced construction will hold it flat, but it is unfit for an open shelf. Before buying plywood, sight across the sheet toward the light in search of dips and hollows due to shrinkage in joints made during manufacture. Such defects cannot be remedied.

Solid lumber of uniform color should be selected when possible to make unnecessary the difficult job of matching parts by bleaching or staining. There are advantages in buying rough stock that is sufficiently thick to straighten by planing. It often yields pieces thicker than 7/8" that, if purchased as standard dressed lumber, would be listed at greater cost.

Lumber for a cabinet is usually cut into oversize pieces to allow for straightening and finish-cutting at the ends. If finished lumber of the right width is at hand, work it directly into parts. But allow ample width for straightening, as in Fig. 7, when a piece is ripped. This is especially necessary if there is doubt about the seasoning, if the lumber has been in the rack for some time, or if there has been a marked change in humidity. The edges may be drier or damper than the center, causing strains that spring the ends apart or pinch them together as the board is ripped. To offset this an

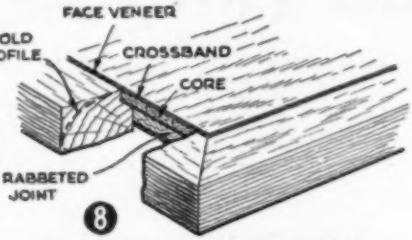






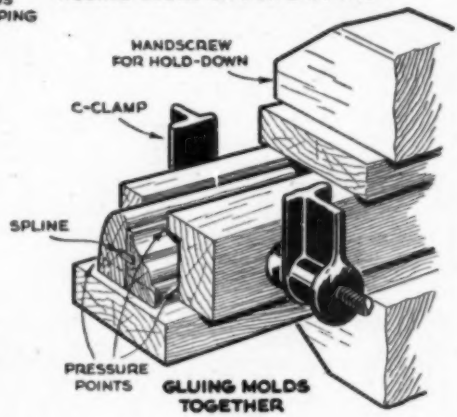
MAKING BOARDS FROM ROUGH STOCK

7



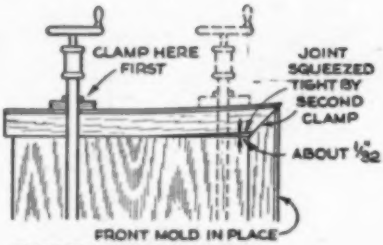
8

NOSING GLUED ON FOR SHAPING



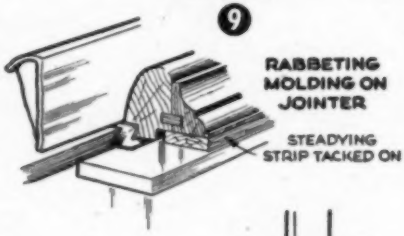
GLUING MOLDS TOGETHER

9

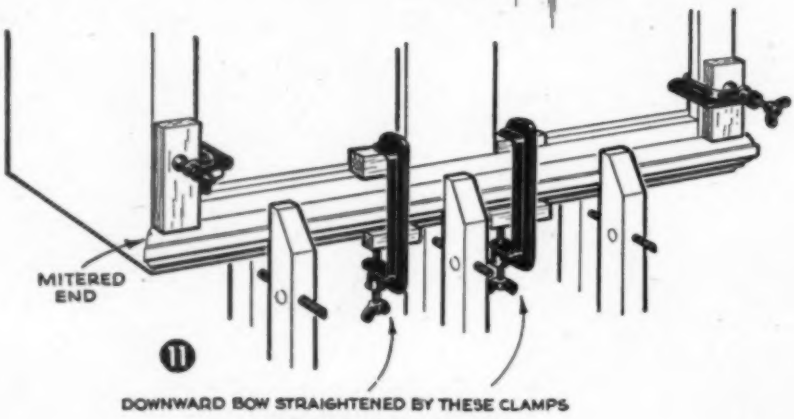


GLUING MOLDING TO TOP

10



RABBETING MOLDING ON JOINTER



11

STRAIGHTENING MOLDINGS

extra width is needed for planing straight the edges of the ripped boards.

A rod, which is a full-size sectional drawing on thin plywood as shown in Fig. 2, helps prevent mistakes. It should give complete sections of all parts, with such additional details as seem necessary. Dressed stock is marked for size by contact with the rod, and measuring with a rule and the danger of misreading fractions are eliminated.

The order in which work is done depends somewhat upon equipment. In general, it's good practice to make gluing one of the first tasks, as the glue can dry while other operations are in progress. Mortises, tenons, and the like are more easily laid out and cut in rectangular stock than in pieces that have been rabbeted, grooved, or molded.

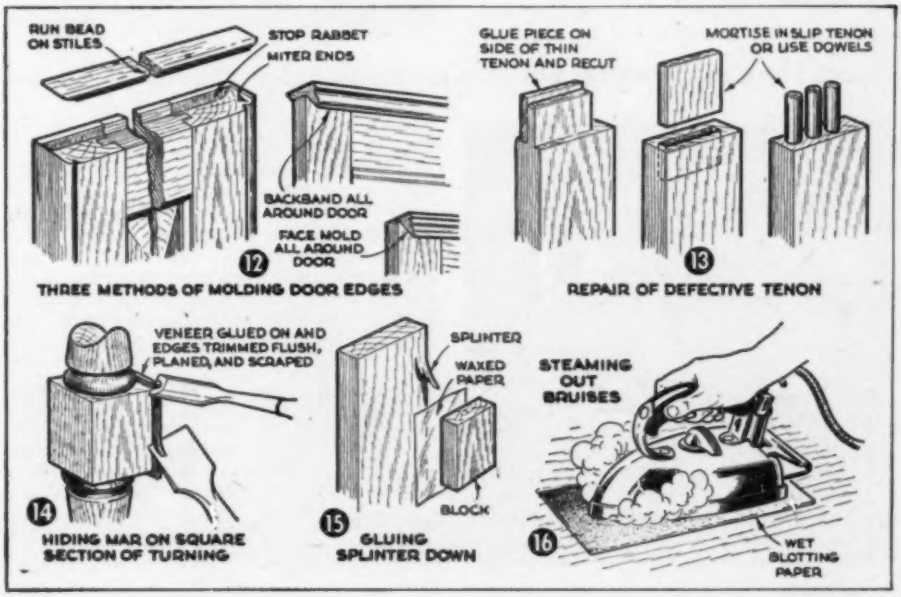
If doors are built after the carcass is assembled, they can be made to fit the openings in spite of changes or mistakes; but in general it is safe to complete them when convenient, leaving stiles and rails extra wide to allow for fitting. It is sometimes convenient to mortise a stile after it has been glued to a side with a lock joint, as in Fig. 4, in order to locate the mortise accurately even though the stile has been inaccurately placed.

With a setup like that in Fig. 5, a dado saw will cut slots in legs to receive shelf corners. The strip of wood clamped in front limits the length, and that on the miter-gauge extension locates the dado at the proper distance from the top of the leg. A chisel squares the front ends of the dadoes.

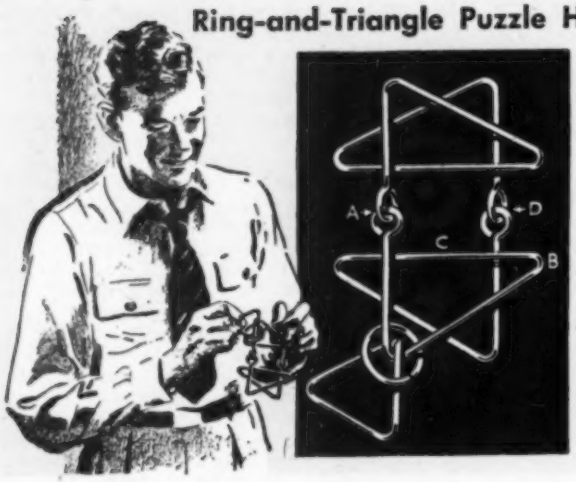
Because of differences in shrinkage and swelling, applied moldings are unsatisfactory on solid tops. By gluing strips to the edges of a plywood top, using rabbets, tongues, or other means to increase gluing surface, as in Fig. 8, you can treat the assembly as one piece and mold it accordingly. Small shapers do not have the reach for cutting deeply stepped moldings, which must therefore be made in two or more strips and glued together or applied separately. In gluing, splines (Fig. 9) not only increase the gluing surface but also help alignment.

Fit a front molding first, obtaining its length by holding it in place and scribing with a knife point. If it is too long, dress one end; if it is slightly short, plane the back lightly. Clamp it in place and fit the mitered ends of the end moldings to it; then glue the front molding on, adding the others when it has dried, as in Figs. 3 and 10. A method of straightening sprung molding is shown in Fig. 11.

Figure 12 illustrates three methods of molding the edge of a door, the second being a means of enlarging a door that is too small. Mistakes almost inevitably occur, but much can be done to remedy them. If a tenon is spoiled, the rail can be salvaged as suggested in Fig. 13. A damaged square on a turning can be veneered (Fig. 14); a splinter or loose bit of veneer can be glued in place (Fig. 15); and dents and crushed corners can be raised by steaming (Fig. 16).



Ring-and-Triangle Puzzle Has Tricky Solution



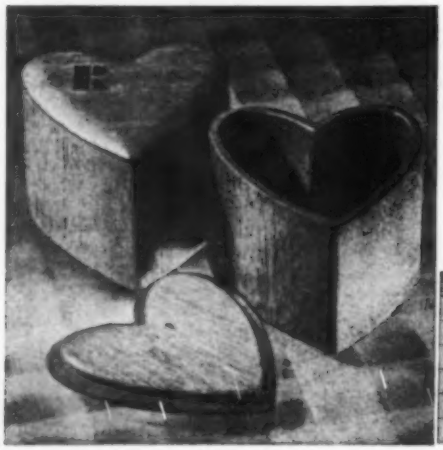
AT FIRST glance the ring seems on this puzzle to stay. But lift it and the triangle to *A*, fold the upper section forward against the lower, pass the ring down over both uprights to the starting point, up to *B*, and left to *C*. Then turn the front half up and back against the lower, pass the ring on to the left, down the two diagonal wires, up to *D*—and it's free.

Coat-hanger wire, rubbed with steel wool, will make the puzzle. Solder the joints.—GEORGE BARR.

Coiled Wire Yields Chain Links

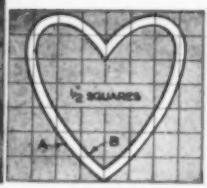
STAINLESS steel welding rod 3/32" in diameter provided the links for the chain and bracelet at the right. Polish the wire, insert it in a hole drilled in a ¼" rod, and wind it on the rod in a lathe or drill press. Cut the resulting coil lengthwise with a hacksaw or milling machine, and you have a pile of links. Assemble them with pliers, first taping the jaws to prevent them from scratching the steel.—DONALD E. WETZLER.

Heart-Shaped Jewelry Boxes Cut from Solid Blocks of Wood



WOOD for this matching pair of heart-shaped jewelry boxes was picked up in the Philippines. Resembling mahogany, it originally came from Australia as part of a crate for Army rations. My wife's initials are inlaid on the covers with ebony.

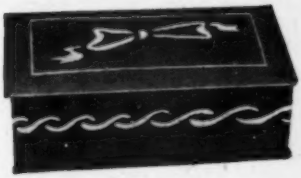
Standing about 2½" high, each box was cut from a solid block of wood to the shape indicated on the accompanying drawing. This may be done with a coping saw, though a jigsaw would be preferable. Each bottom piece was sawed and sanded to a press fit and glued into place inside the box. The top consists of two pieces glued together, the upper shaped to line *A* and the smaller cut inside line *B* to give an easy fit.—EMIL GAYNOR.



Something NEW *from Something* OLD

STENCIL CRAFT TRANSFORMS ODDS AND ENDS INTO ATTRACTIVE ONE-OF-A-KIND NOVELTIES

Tins and other boxes, lacquered and stenciled, make containers for cookies, sewing materials, and trinkets. The serving tray at right was originally a cover for a restaurant-size lard can.

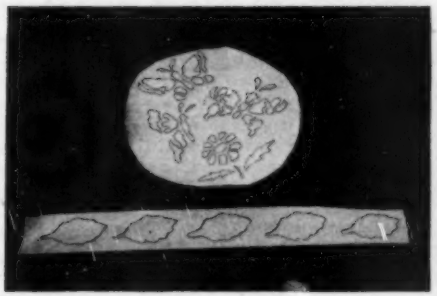


BOXES for cookies, cake, candy, and sewing materials, and even attractive trays and other novelties, can be made from tins, jars, and boxes ordinarily consigned to the trash pile. The addition of two coats of black lacquer or quick-drying enamel and the deft application of small decorative stencils work the transformation.

In the photos above are two ornamental boxes, one from a round packing tin in which fruit cake was received and the other from a gilded metal candy box. Wooden boxes and glass jars serve the same purpose, and, if necessary, new tops can be made for them from scraps of plywood or other stock. The tray originally covered a large lard can in a restaurant.

Clean the piece thoroughly first, removing paper labels and the like; then, after it has dried, lacquer or enamel it all over. Suitable stencils may be purchased from an art-supply store, or they may be cut from heavy gummed paper. The latter course allows for a great deal of originality and contributes to that one-of-a-kind quality. Curved cuticle scissors, if they are available,

Designs for the stencils are drawn or traced on heavy gummed paper. Small figures show up best.



Cut out parts to be colored, leaving connecting lines between. Use cuticle scissors if possible.

Stencils are glued firmly to the surface with no loose edges left for paint to get under; then the thick enamel in bright colors is applied lightly with a camel's-hair brush to give the effect shown at right.

will help you in getting nice, sharp corners.

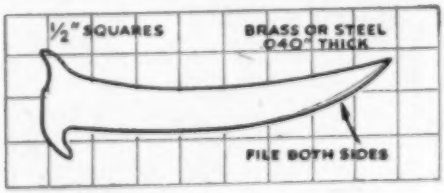
Stick the entire stencil to the surface to be painted, taking care to see that there are no loose edges under which paint can seep. If this is done properly, a camel's-hair brush can be used for applying colorful enamels in the cutouts. Have the paint rather thick. When it has dried, soak the piece in warm water to loosen the glue, and the stencil is quickly removed—ELMA WALTNER.

Bullet Is Paper-Knife Handle

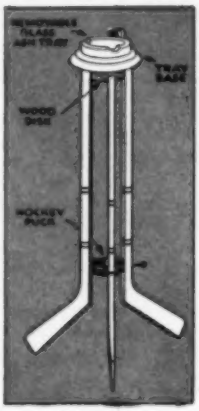
BOTH the steel-jacket bullet and the shell of a .30-cal. cartridge are used for the handle of this paper knife, while the blade is a strip of .040" brass or steel cut and filed to the shape shown below.

The bullet must be carefully removed from the shell by gripping it in a chuck or a vise, or holding it in some other way without damaging it, and working the shell loose. Remove the powder from the shell, taking care to dispose of it where it can do no harm, and destroy the shell primer by firing the empty shell in a rifle.

Next, saw a .040" slot in the bullet from the nose to the knurled ring. Polish bullet, shell, and blade, solder the blade in the bullet slot, and reassemble the bullet and shell. Plate the entire knife with chromium or nickel and polish again.—J. C. M.



Hockey-Stick Legs on Ash Tray



THREE hockey sticks make the legs of this stand for the sportsman smoker. They are drilled through and attached with six screws to the wood disk that holds the tray base at top and to the puck near the bottom. The tray base is turned to accommodate a heavy glass ash tray that can be removed for cleaning. Finish with clear varnish and wax.—A. A. LEC.

Stapling Loose-Leaf Notebooks

USED leaves of a loose-leaf notebook can be kept from tearing by fastening them together in groups of a half dozen or more with ordinary paper staples placed with a hand stapler near the ends of the pages in line with the perforations. If the holes are already worn or torn through, the staples should be placed just back of the original perforations to serve as reinforcements. Either method results in a less bulky book than the use of gummed reinforcements, and saves time.—WALTER A. SIMOND.

Home Repairs for Fountain Pens

ALMOST everybody has at least one fountain pen that refuses to write properly. It may spill sudden blots and ruin a letter or important paper, or it may write irregularly, requiring shaking to get the ink to flow. Another common ailment is a failure to fill with ink. Whatever the trouble, it's not hard to sit down with a few common repair items and do your own servicing.

Sometimes blotting can be caused by so simple a thing as failing to fill the ink reservoir completely. When the rubber container in the barrel is compressed in the operation, air is expelled, and the partial vacuum pulls the ink in. If all the air is not expelled, or if air leaks in when the ink supply is low, the vacuum will be reduced and may not be able to hold the ink back. The obvious remedy is to press the lever all the way when preparing to take ink in and also not to wait until the reservoir is dry.

There are other causes of blotting that can be corrected with mechanical repairs. If the ink feeder—that little black plastic or hard-rubber part under the pen point—has been damaged, it must be replaced. Look at the narrow groove along its upper side. A break in it may allow too much ink to flow. Look, too, at the pen point. A tiny ball of hard iridium just under the gold tip ordinarily takes all the wear and is long-lasting. If the gold tip, however, has been damaged, the slit from it to a hole at the center may not close completely when the pen is taken from the paper, and ink may continue to flow. In this case a new point will be needed.

Warm water to which a little household ammonia or washing soda has been added is a good pen-cleaning liquid. Dried ink and other obstructions frequently can be cleared out without dismantling the pen by simply filling and emptying the reservoir several times in a bowl of the cleaning fluid. If this is not sufficient, open the barrel of the pen just below the threads with a twisting and pulling motion and examine the pliable reservoir, which may need to be replaced. When the point and feeder must be removed, clean them with a toothbrush and the ammonia water before reinstalling them.—HAROLD P. STRAND.

Warm water and ammonia, a toothbrush, shellac, and replacement parts will put a pen in order.

Opening the barrel with a twist and a pull just below the threads gives access to the reservoir.

If the reservoir is undamaged and still pliable, cleaning can be done without further dismantling.

Badly worn reservoirs must be replaced. The one shown below had rotted and the barrel was caked.

With a slight twist, the nib and feeder will pull out in the fingers. Ammonia water loosens them.

Brush off the parts with the cleaning liquid and examine the point and feeder for damage and wear.

Shellac applied around the inside edge of the new reservoir will hold it firmly to the shank recess.

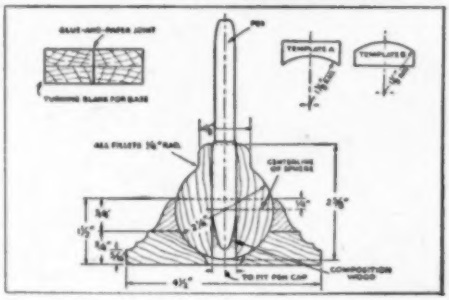
The final test is in writing. A pen should write uniform lines smoothly without too much pressure.

Desk Holder for Fountain Pen Is Turned from Hardwood

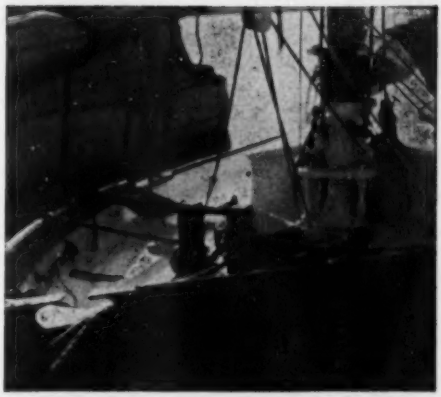
THREE scraps of cherry, walnut, mahogany, or other nicely grained hardwood and a fountain pen from which the spring clip has been removed will give you a handsome desk-pen set. Turn the ball first from a 3" length of $2\frac{1}{2}$" turning square, using a template cut as shown at *A* to obtain a true sphere. Bore a hole all the way through to fit the pen cap, press the latter in, and hold it with plastic composition wood.

Glue two 5" squares of ¾" stock together, as indicated in the drawing, rip them in half with the grain, plane the ripped faces smooth, and reglue the two halves with a piece of paper between them. Mount the assembly on the faceplate and turn the concave inside only, using template *B* as a guide. Split the halves at the joint and try them on the ball for a fit. Mark for corrections, if necessary, reglue and turn until the fit is perfect. Then finish the ball and the turned inside as desired.

Next, glue the halves around the ball without paper, taking care to see that the ball moves freely, and turn the outside to the shape shown. Finish to match and glue felt on the bottom.—ERNEST A. RICHMOND.



Carving Name of Boat Makes It Stand Out Strikingly



ANY boat, large or small, gains individuality from a bit of carving—its name on the bows or transom and possibly an added embellishment such as an arrowhead, a small star, a scroll, or other suitable motif. Carved and painted letters stand out with much greater visibility on the water, and they are also, of course, much harder to erase or disguise if the boat should be stolen.

Make a full-size paper pattern with the letters properly spaced and transfer it to the boat with carbon paper or pricks of an awl. Thumbtacks will hold the paper in place while this is being done.

Fill in all lines with a pencil, and then cut the outline with a sharp knife, slanting it in slightly and making it about 1/16" deep. Work on one letter or figure at a time, completing it with a small gouge and sanding all rough spots smooth. Paint the letters inside to contrast with the hull, using a flat undercoater as a base.

If carving is to be done on the transom of a boat being built, it will be easier to work before it is installed.—J. A. EMMETT.

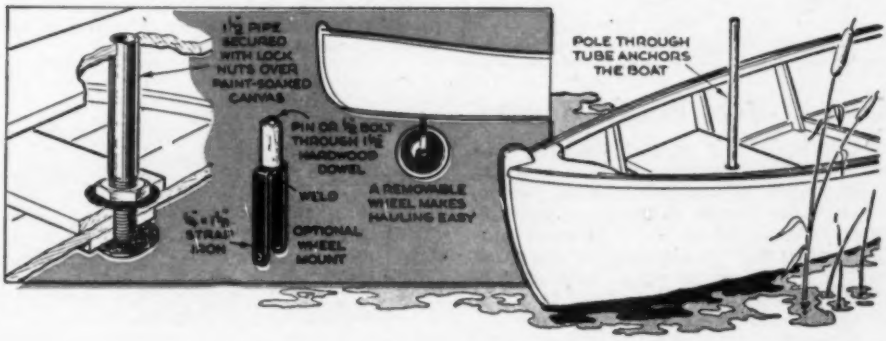
Tube Through Skiff Bottom Helps in Anchoring and Hauling

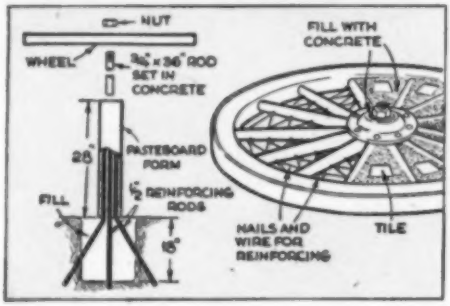
DUCK-HUNTING boats are frequently fitted with a tube at each end for thrusting through poles to keep them from drifting. A single anchoring tube is handy in the average skiff, for a pole is quicker and cleaner to use than the usual anchor or weight.

Use a piece of 1½" i.d. brass or galvanized pipe threaded on one end and long enough to reach flush from the top of the forward seat to a good ½" outside the bottom. Line the hole up carefully to miss seams and fastenings. Bore through all bottom construction—keelson, bottom, and any outer keel—holding the bit at right angles to the bottom even if it means tilting the pipe slightly aft. If a fastening should interfere, get the hole to correct size with a narrow chisel and file; then enlarge the hole in the seat to line up.

Soak two canvas gaskets in marine paint, put the tube through the seat, thread a lock nut on its bottom end, add one of the gaskets, and turn the threads through the bottom hole. Put on the other paint-soaked gasket and a second lock nut and tighten the two nuts until the paint oozes from the gaskets.

A fork made as shown can be used to mount a wheel for easy hauling.—J. A. E.





Wagon-Wheel Garden Table

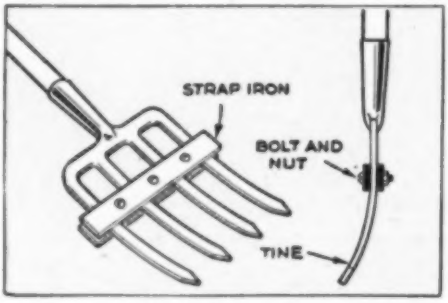
WHAT is more appropriate as informal outdoor furniture than a wagon-wheel table? The one shown at the left was made up from an old wheel obtained from a blacksmith. An 8" diameter cardboard linoleum packing tube served as a form for the column.

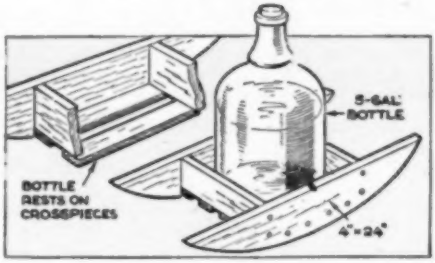
Dig a hole for the base and insert three ½" reinforcing rods. Slip the cardboard form over the rods, bind it at several places with wire for support, pour full of concrete, and force the ¾" rod into the wet concrete.

String reinforcing wire between nails in the wheel spokes and tack light boards on the underside. Put the hub over the projecting rod and draw the nut tight. Then build scaffolding to hold the wheel steady and pour concrete between the spokes. Colored tiles were set in for the table shown, and when the scaffolding and boards were removed, the spokes and rim were painted red. For garden furniture, a 1-1¾-2 concrete mix is customary.—CHARLES L. HEAD.

Depth Gauge for Spading Fork

WHEN the depth of penetration of a spading fork can't be controlled, extra work is added to the job of turning soil. A simple depth stop like that shown below can be made from strap iron and bolted between the tines. It saves time and assures turning to uniform depth. The stop can be adjusted for different depths as desired, or it can be entirely removed when necessary.—J. K.



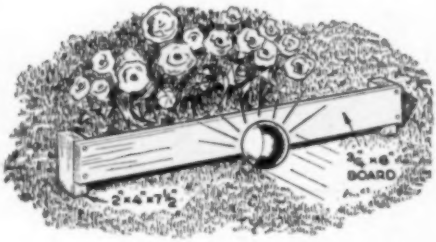


Insecticides Agitated on Cradle

SOMETIMES it is convenient to mix solutions for garden sprays in quantity, such as in a 5-gal. bottle, but then proper agitation without danger of breaking the container becomes a problem. A wooden cradle built like that shown above will agitate the liquid sufficiently with complete safety if water and chemicals fill the bottle only about three quarters of the way. Use of a long stick or paddle is unnecessary. Sprayers can then be filled as needed.—W. O. DOWNS.

Croquet Stops Protect Flowers

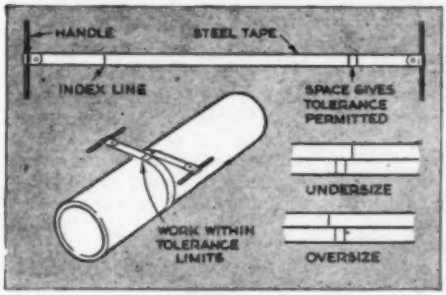
BALLS struck by croquet mallets sometimes have the disquieting habit of bouncing across walks, hiding under hedges, or injuring garden plants. A number of portable guard rails placed at strategic spots may add considerably to enjoyment of the game. Painted a harmonious color, they may be left out through the summer and taken up for winter.—KENILWORTH H. MATHUS.



Revolving Table Speeds Up Assembly of Print Jobs

THIS revolving table is used in the print shop at the Michigan State Reformatory for assembling the pieces of multi-unit print jobs. The inner circular section revolves within an outer stationary table, and the worker picks up one unit from each of the piles of printed matter on the inner table as they pass him.

An electric motor operates the revolving table through a gear-reduction unit that can be set to one of three speeds. The unit is desk high, the center table is 48" in diameter, and the outer rim is 12" across. As compared with the method of assembly while walking beside a long table, the unit has speeded up production of print jobs approximately 300 percent.—TED DOUGLAS.



Tolerance Gauged with Tape

TOLERANCE of work produced at the Youngstown Sheet & Tube Company is checked with a novel type of gauge. An index line and two lines to represent the absolute maximum and minimum acceptable circumference are scribed on a strip of steel tape. In use, the tape is wrapped around the work. If the index line falls between the tolerance lines or flush with either, the work passes inspection. If it falls outside, the work is either over or under.—JOHN KRILL.

CLEANING WALLPAPER [*SHIPSHAPE HOME*]

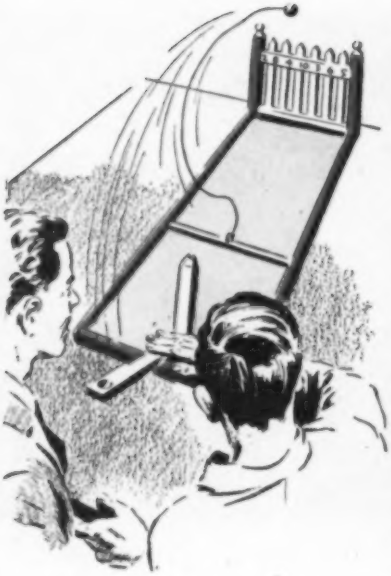
If an entire room needs attention, first dust the walls with a vacuum brush. Then cut a fresh loaf of rye bread squarely in half and use the cut face to clean the wall areas from the top down, rubbing in straight, partly overlapping strokes. When the bread becomes soiled, cut off a slice and expose a new area. A drop cloth on the floor will catch the crumbs.

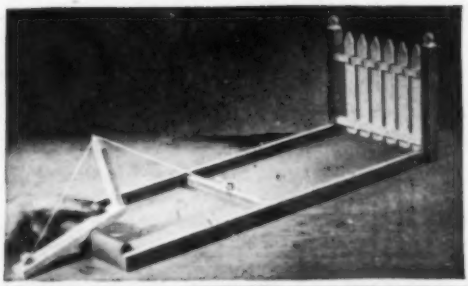
Four parts of flour and one of powdered sal ammoniac (by weight) mixed and kneaded together with enough water to make a puttylike mass also will help brighten soiled paper. The mixture may be used until it will take up no more dirt.

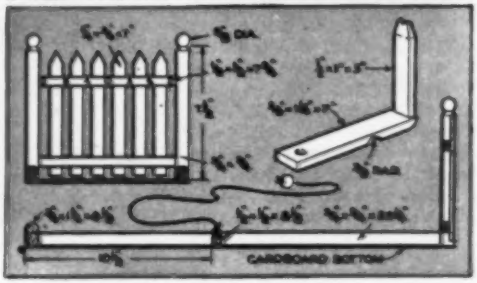
Press a pad of blotting paper against a grease spot with a moderately hot iron. After all the grease possible has been extracted in this way, dust the area with a little pipe clay or fuller's earth. Remove the powder with a soft brush after it has been on the paper for a few minutes. Finger marks should be dampened with cold water and then treated with pipe clay or fuller's earth in the same way.

Many spots may be removed with an ordinary pencil or ink eraser, but bear lightly on the eraser or the pattern may be rubbed off. Touch ink spots lightly with water, apply a blotter, and then treat with oxalic acid. Water colors or crayons may be used to touch up the colors of the paper if they are affected.

POPULAR SCIENCE MONTHLY SHOP DATA







Ball Flying over Picket Fence Scores in Unusual Table Game

TIED to the end of a string and catapulted with a sharp flip, the wooden ball in this game will sail through the air and land beyond the little picket fence. As it does, the string drops between two pickets—and the score marked on the crosspiece there counts for the player, who gets three shots.

Dimensions for the game and board are given in the drawing. Make the frame of ½" by ½" stock except for the end nearest the player, which is ¾" by 1¼"; then tack a sheet of show-card stock to the bottom. Next, build a light picket fence at the far end, using six pickets and two end posts. Paint in contrasting colors, and number the seven spaces between pickets as indicated.

The catapult is made of two pieces of stock glued and screwed together at right angles, as shown in the drawing. In the longer piece is a groove to pivot on the rounded part of the board frame, and the upright is notched.

To play, put the ball in the depression at the end of the catapult with the string in the notch in the upright, as indicated in the photo. If you snap the front of the catapult down with the fingers, the ball will go flying.—MYRON FLEISHMAN.

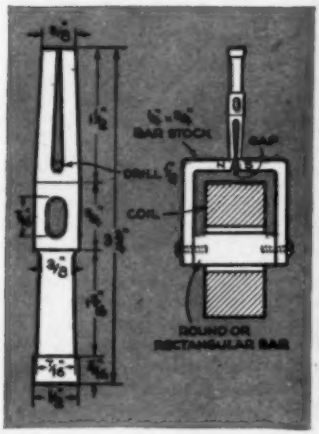
Typed Cribbage-Board Pattern

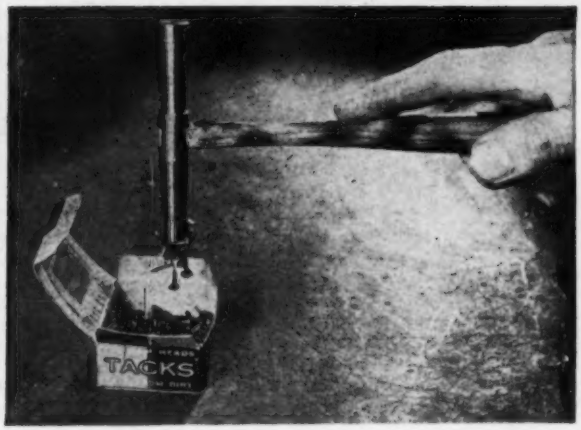
IF YOU have trouble in finding a board for three-handed cribbage, it isn't hard to make one yourself by using a typewriter to space a template. With a piece of paper in the machine, strike the period key and space bar to get the spacing you wish, and then attach the paper to a suitable piece of wood with rubber cement. Prickpunch the periods, drill in blind holes, strip off the paper, and finish the board as desired.

The board shown was made of ¾" by 3" by 12" stock. Three spaces were allowed between each pair of periods, and six spaces between pairs. The lines were double-spaced down the board, with four lines between groups.—JERRY SPRAGUE.

No Bruised Thumbs with This

MAGNETIC TACK HAMMER





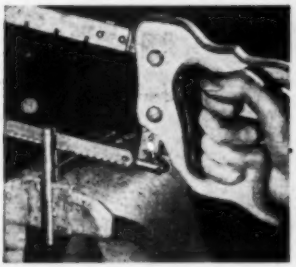
WHEN one end is a horseshoe magnet, a light hammer will pick up and place a tack or small nail without requiring it to be held, thus saving many a sore finger. Drill rod was used for the hammer shown. The striking end is first turned to the shape shown above; then the magnet end can be slotted with a hacksaw. Enlarge the slot to ⅛" with a thicker hacksaw blade, two or three blades side by side, or a slotting blade. Finish the slot end with a round file. Or, if you prefer, drill a ⅛" hole first and saw to it. Press the prongs almost together in a vise and turn the taper.

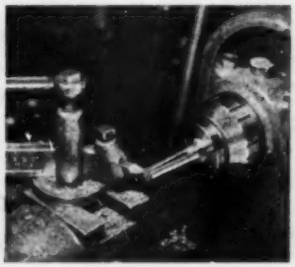
Drill and file a handle eye (see P.S.M., Dec. '45, p. 174). Then bind the prongs with iron wire to prevent spreading, and harden and temper one end at a time.

The hammer must be magnetized so the split ends present opposite poles and there is no magnetism in the other end. An open-solenoid magnetizer (see P.S.M., Oct. '43, p. HW 488) may be used if fitted with two bent pieces of bar iron bolted to the end of an iron core, as in the drawing. Touch a prong to each pole and turn the current on for an instant.

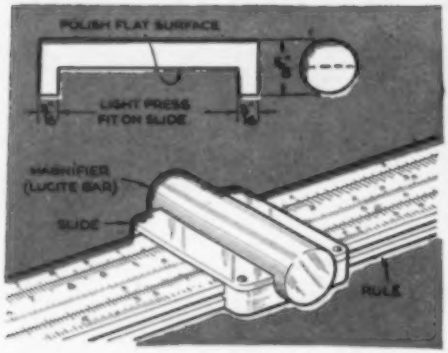
Or you may use an old 6-volt loudspeaker field coil of the type that has a narrow, annular voice-coil slot. Bridge the slot with the prongs, spreading them slightly with a nonmagnetic metal if necessary for better bridging and maximum effect. The coil may be connected directly to the 115-volt A.C. line if the current is turned on only momentarily, or to a battery or rectifier. In the first case maximum magnetic strength will depend on the point in the A.C. cycle at which the circuit is broken, so several attempts may be required.—ERVIN WALTERS.

One end of the hammer is slotted (left), the prongs are bent together so paper will just pass between them, and the pronged end is machined to a taper (center). Right, magnetizing on a loudspeaker coil.



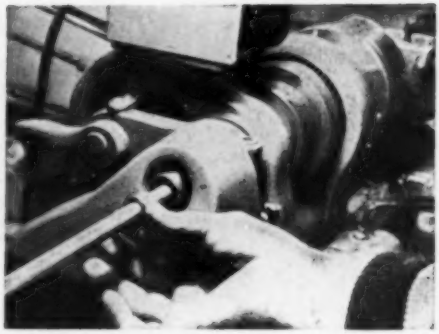


NEW SHOP IDEAS



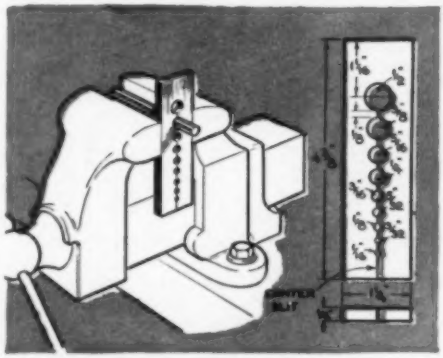
MAGNIFIED READINGS on a slide rule are possible with the attachment of a semi-cylinder of plexiglas or lucite on the reading slide, as shown in the drawing above. The clear-plastic magnifier is filed to the shape shown in the top drawing, with the two ends left cylindrical and so spaced as to make a press fit on the slide. Polish the flat surface. Center the magnifier on the slide crossline.—RALPH D. CURTIS.

ADJUSTABLE PARALLELS and planer gauges can substitute for special fixed gauges when the carriage stop is used for turning shaft shoulders to decimal lengths or boring to decimal depth. These are standard tools available at large hardware stores. They are especially handy when small quantities are machined and it is impractical to make a special gauge or spacer of the same size as the length of shoulder or depth of hole. The photo shows a planer gauge being used as a carriage-stop gauge and adjustable parallels set and ready for use.—J. C. M.



TO REDUCE WHIP at the outboard end of long bar stock held in a collet or chuck for turning, slide a collar or bushing over the stock and into the spindle, as shown above. Make up a set of collars to fit various sizes of stock most frequently used, and taper the outsides slightly so they will fit snugly in the end of the spindle. A sticking collar can be removed by tapping from the chuck end.

This precaution is especially necessary with stock ¼" in diameter or less, which can cause serious injury if it extends as much as 12" beyond the spindle with no outboard support.—J. C. MAGEE.

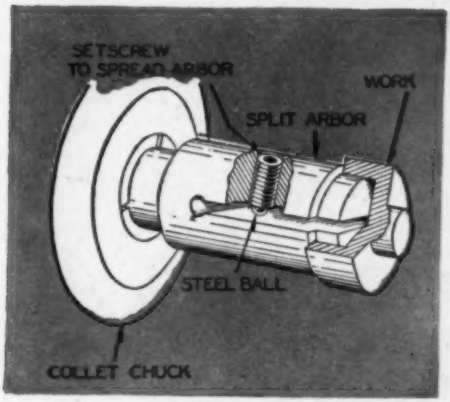


HOLDING TUBING IN A VISE without danger of crushing its wall is easy with a drilled and slit bar like that shown in the drawing above. Make the vise tool from brass or other soft flat stock. Lay out and drill holes from 1/16" to ½" in diameter, as shown in the drawing; then with a hacksaw slit the piece from the end nearest the small hole through the center and into the ½" hole.

This cut permits spreading the ends slightly so tubing, bolts, screws, and other round stock of sizes from 1/16" to ½" can be pushed through easily. Pressure of the vise jaws will hold the piece firmly while it is being sawed or filed.—JOHN SHEST.

SURE-GRIP ARBOR. Smooth and positive expansion is insured by the use of a 3/16" bearing ball under the setscrew of this split arbor, which will withstand the wear of long production runs. The arbor can be held in a collet or, if large enough to permit a truing cut to be taken, in an ordinary three-jaw chuck. A twist of the setscrew grips the work or frees it. The setup is especially good for light facing or finishing cuts.

This adaptation of a split arbor is the idea of Alfred Guthenberg, of New York. It was originally published in *Blue Chips*, a publication of the Warner & Swasey Co.



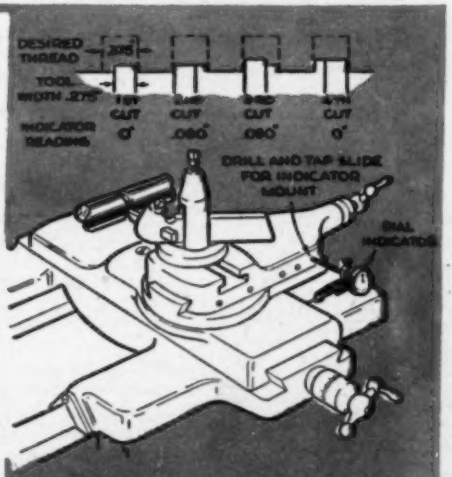
FINDING THE RIGHT WRENCH will be automatic if you grind down all adjustment nuts and boltheads in the shop so they will fit one end or the other of the standard double-end wrench furnished with most screw-cutting lathes. Nuts and bolt heads on the lathe, drill press, vise, clamps, and the like may be ground or filed to size, or new ones can be machined.—WILL THOMAS.

SQUARE OR ACME THREADS are easier to cut if a dial indicator is mounted on the compound-rest slide. Roughing out is possible with heavy, chatter-free cuts, the effect of lead-screw backlash is eliminated, and the lathe need not be stopped for measuring.

With a micrometer, measure the width of the tool, which must be narrower than the desired thread width. Then take a first cut with the indicator reading at zero. For a second cut, advance the compound rest until the indicator shows the difference between tool and thread width less .010" for a finishing cut. Thus, for a .375" thread cut with a .275" tool, the reading is .090".

Take the third cut at the same indicator setting with the tool advanced into the work with the cross feed. Return the compound rest to the original indicator reading of zero for the fourth cut, and so on.

Make the first finishing cut on the right of a right-hand thread to nullify lead-screw backlash, the final cut on the left with the compound advanced the full difference between too and thread width.—A. R. P.



Mounting an indicator on the compound-rest slide to gauge a thread. A spot filed on the cross slide provides a bearing for the button. Cutting procedure is shown at top.

THE WHEN AND HOW OF

New Solutions to Tough Shop Problems Appear Like Magic As You Master Hard-Soldering Techniques

By VERNON B. CASE

HARD-SOLDERING is easy. It is also one of the most valuable techniques available to the craftsman for making metal-to-metal joints, being simple, neat, and extremely strong.

The novice is apt to confuse hard- or silver-soldering (sometimes also called silver-brazing) with ordinary or soft-soldering. They are, of course, entirely different procedures. Ordinary soldering involves low heat, usually around 350 deg. F., and a solder made of a tin-lead alloy. The resultant joint, though useful in its place, possesses scant mechanical strength and is useless in high-temperature applications. Hard-soldering employs a silver alloy melting at temperatures of from about 1,100 deg. F. up, and produces joints that are short only of welding in strength. Brazing, which involves the use of "spelter," a brass alloy, is similar to hard-soldering and usually requires a temperature of 1,600 to 1,800 deg. F.

If you have ever been exasperated by the weakness and unreliability of soft-soldered repairs or assemblies, the simplicity and clean strength of silver-soldering will appeal to you. Given a good source of heat and a supply of suitable solders and flux, you'll find that you can easily and reliably create joints practi-

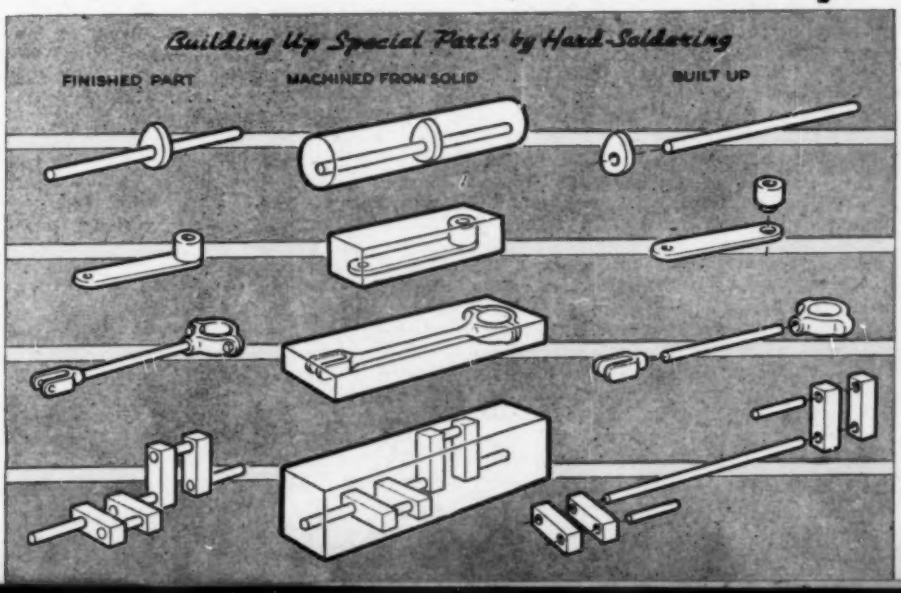
SILVER-SOLDERING AND BRAZING

cally equivalent to one-piece construction. The drawings at the bottom of the page show one application of this remarkably useful technique; by building up irregularly shaped parts, instead of machining them out of solid stock, it's possible to eliminate the task of laboriously removing unwanted metal. The built-up parts are in no respect inferior to those shaped from one piece; in industry, parts involving exacting specifications—auto camshafts, distributor shafts, and shaft housings, to name a few—are now sometimes manufactured in just this way.

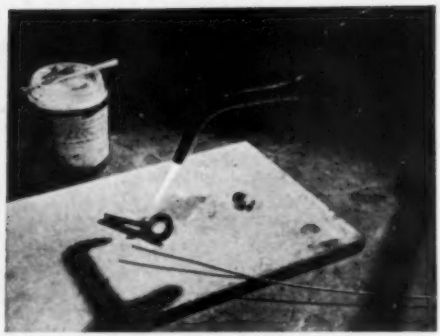
The home craftsman will find scores of uses for hard-soldering. In making jewelry, models, and tools or instruments, the ability to do hard-soldering is almost essential to fine work. Repairs of all kinds are also greatly aided by this technique; it is even practicable to restore broken drills or taps of high-speed steel. Silver solder and various patented alloys that behave in much the same way are obtainable in such forms as wire, bars, strips, sheets, pellets or granules, and small chips. These solders come with different melting points, which is valuable when more than one soldering operation has to be done on the same piece.

Getting enough heat on the work is important to silver-soldering. A small alcohol torch will do for fine jewelry-making and similar light work. Ordinary Bunsen burners, or even a kitchen gas stove, can be pressed into service for small to medium-sized tasks. A gasoline blowtorch or a simple gas-air torch (see P.S.M., Dec. '44, p. 192) will handle most of the jobs the craftsman is likely to encounter. A home-made brazing torch employing a small tank of acetylene gas (see P.S.M., June '42, p. HW 38) is very handy. For work involving good-sized masses of metal, an oxyacetylene torch is ideal, of course, but it is also possible to use a twin-carbon arc torch (see P.S.M., Oct. '41, p. 194).

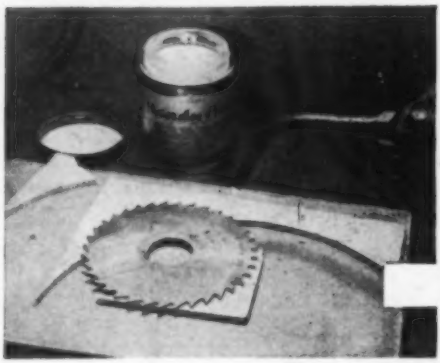
For a glimpse at hard-soldering procedure, let's suppose you are making a piece of metal jewelry and want to solder a pin

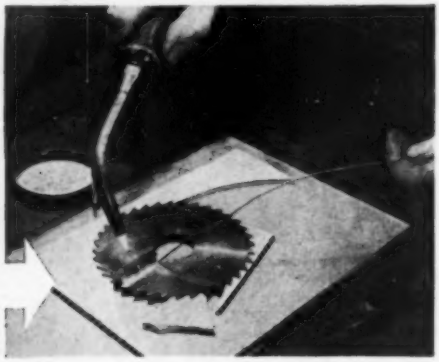


Silver-soldering a pin to a brooch. The borax flux was mixed on a jar lid, and applied with a brush.



If a thumbscrew is needed, you can make one in a jiffy by brazing a washer in the slot of a screw.





Repairing a costly slitting saw of high-speed steel. It is first gently heated opposite the break to expand the crack for cleaning and fluxing. When the crack closes again, it is then carefully brazed.

and catch to the back. First, mix a bit of household borax with water to make a thick paste. Pour out a few tiny chips of silver solder or cut some chips from a strip (you will only need a few tiny bits). After wetting these with the borax, pick them up with tweezers or with the end of an artist's brush and place them on the cleaned work, adjacent to the desired joint.

Warm the work gently with a torch until the water in the flux evaporates; if you heat too fast at first the flux may boil and steam, displacing the silver chips. As soon as the flux dries out, heat the work rapidly, keeping the torch moving to distribute the heat. Soon the borax will become molten and before long the solder will follow suit. Solder always flows toward the hottest part of the work; by keeping this in mind, you can make it behave the way you want to. Another thing to remember is that the heat should be applied more directly to the heavier parts, or to the parts that conduct heat more rapidly. If the solder clumps into little balls instead of flowing freely, the work is either dirty or not hot enough. Properly handled, silver solder will flow into a joint with the fluidity of quicksilver.

After the joint has been made, let the work cool a bit and then wash it in hot water. If the jewelry is silver, you may wish to pickle it in a hot sulphuric acid solution (1 part concentrated acid to from 10 to 40 parts water). If there are two or more joints on a piece, use solder having a high melting point for the first one, some with a medium melting point for the second, and a low-melting-point solder for the third. Another way is to cover previously soldered joints with a water paste of powdered asbestos or fire clay.

Unless you want to invite failure, the surfaces to be soldered must be cleaned scrupulously. Remove grease with soap and water or carbon tetrachloride. Follow with abrasive cloth, steel wool, filing, or wire-brushing to get dry, bare, bright metal. Silver jewelry and the like is usually cleaned by dipping in the acid pickle.

Probably the best way to learn the little

tricks of hard-soldering is to practice on metal scraps until you can produce a neat, strong joint every time. Rapid heating after the flux moisture has evaporated is usually desirable to retard oxidation. The purpose of the flux is to dissolve oxides that would otherwise prevent the union of the solder and the metal being joined. Since heat itself produces oxides, a short heating period will give the flux less work to do. With oxyacetylene and twin-carbon arc torches, though, don't use so fast a heating rate as to melt the work itself.

Although borax has long been used as a flux, there are other special fluxes that usually do a better job of encouraging the solder to "wet" the metal, and that are less troublesome to remove after the job is done. However, borax does not give off any harmful fumes under heat, while some of the prepared fluxes do. These fumes, which include those of hydrofluoric acid, should not be breathed nor allowed to touch the eyes or skin. Good ventilation is the best insurance, but take care not to chill the work with any strong current of air. An asbestos or firebrick screen around the work will shield it against drafts.

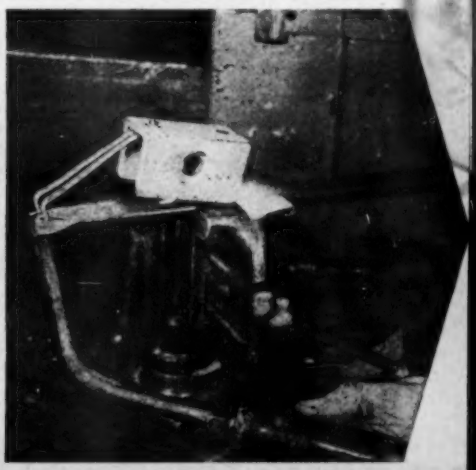
If you are just venturing into the field of hard-soldering and brazing, you will find the following useful: A torch suitable for the size of work contemplated. Some hard-soldering alloy melting at 1,175 deg. F., in the form of 1/32" wire, and some similar alloy in the form of strip .003" thick and 1" wide. Some rods of brazing spelter. A small jar of prepared flux and a box of household borax. A few pieces of sheet asbestos or firebrick on which to support the work, several C-clamps, and some iron wire. Except for the torch, all this need not cost more than two or three dollars.

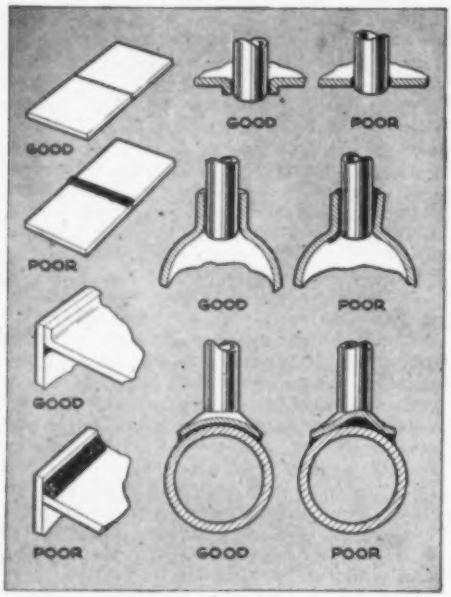
Some of the things that can be done with hard-soldering are almost magical. Broken parts that threatened to stall industrial production lines for weeks have been repaired in hours. In one instance silver solder was used to repair a shattered 1⅝" high-speed-steel tap that could not have been replaced with a new one for six weeks. The eight pieces of the tap were degreased, fluxed, fitted together like a jigsaw puzzle, and clamped. Only 3" of 1/16" silver-alloy wire were needed, for the molten solder flowed by capillary action through all parts of the break. Four hours after the tap failed it was back on the job, and months later it was still there.

Cracked high-speed-steel slitting saws are often repaired with low-temperature brazing alloys. A typical saw failure is caused by a crack running from the mandrel hole to the edge. The saw is laid on an asbestos support and heated gently in the region opposite the break to spread the crack and permit cleaning and fluxing. Then the work is heated to brazing temperature along the crack and the alloy fed in by hand. If done properly, the solder flows thinly into all parts of the break.

A good way of attaching carbide cutting tips to steel or iron shanks is to silver-solder them on with a piece of .003" sheet alloy. The carbide tip is carefully fitted into a recess machined for it, and strips of alloy slightly larger than the joints are sandwiched in, all surfaces being coated with flux. The shank is then heated with a torch until the alloy melts, and the flame is applied for a few seconds to the tip. With a warmed holding rod the tip is moved around to make certain that all joint surfaces are wet, and then held in position until the alloy sets. The tool should next be buried in powdered asbestos or lime to prevent over-rapid cooling. [*Turn the page.*]

Three steps in attaching a carbide cutting tip. Left, the machined shank, the tip, and the two sheets of alloy. Center, flux is applied; and right, the shank is heated. A weighted rod holds the tip down.





High-speed lathe bits can be made to do at least double duty by brazing them to shanks of mild steel. Milling cutters can be formed of boiler plate with teeth of high-speed steel or carbide brazed on. Attachment is the same as with carbide tool bits, except that a lower-temperature (1,175-deg.) alloy is preferable, and care should be taken not to heat the tip more than is necessary. Though the solder can be preplaced, overheating is less likely if the tool recess is first "tinned" with alloy. The tool should be quenched in oil or an air blast; water quenching might cause cracking. It is possible to silver-solder high-speed cutters without lowering the Rockwell hardness more than a few points.

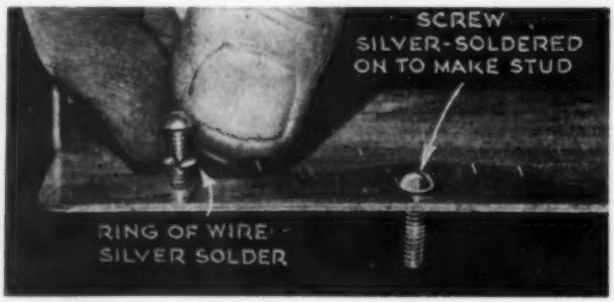
In all kinds of hard-soldering jobs, the preplacing method is usually preferable to hand feeding of the solder. Preplacing means that washers, rings, disks, or other special shapes of alloy are placed in or around the joint, and the work is heated until the alloy unites with the parts of the joint. This eliminates waste by providing just enough solder to do the job, reduces the need for filing and other finishing operations, and helps insure that the solder will flow just where it is wanted.

Good joint design is important in hard-soldering and brazing. In general, a good joint is one that permits relatively large areas to be united by the alloy, as shown in the drawings on this page. Thus a lap joint is preferable, a scarf joint less strong but still good, and a simple butt joint the least desirable. However, as suggested in the detail at the top left, a bead of solder outside the joint surfaces themselves adds little extra strength. Tests with silver solders have shown that a thin film of alloy makes a stronger joint than a thick one. Hence for silver solder, clearance between the surfaces to be united should be on the order of .001" to .003". In brazing considerably larger clearances are required, since most brazing spelters do not flow as freely.

Holding the parts to be joined is often the most demanding part of the job, but clamps, jigs, and soft iron wire will work wonders. Jewelry parts are sometimes held by pinning them to charcoal blocks with iron-wire staples. When joining sections of broken drills or taps, some sort of jig is desirable for accurate alignment.

Silver-solder wire in the shape of a ring, right, makes it easy to attach a new shank to a broken twist drill.

Wire rings of alloy are used, below, to fix machine screws on a plate as studs.

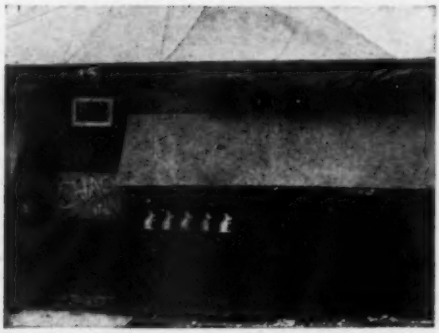


CAN YOU BEAT THESE PICTURES?

We will pay $5 for any photo used on this page. Write your name and address on each print. Enclose a stamped, self-addressed envelope and the negative, if it is available, and send your contribution to the Curious Photos Editor.

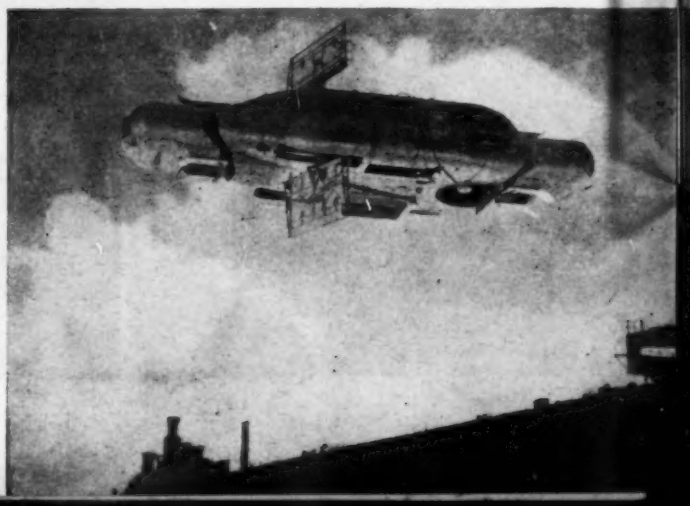
GULLIVER IN LILLIPUT? No, this is just Old Faithful putting on a new act for visitors at Yellowstone National Park. The picture of this steamy snow man was snapped by Mrs. F. B. White, of Titusville, Pa.

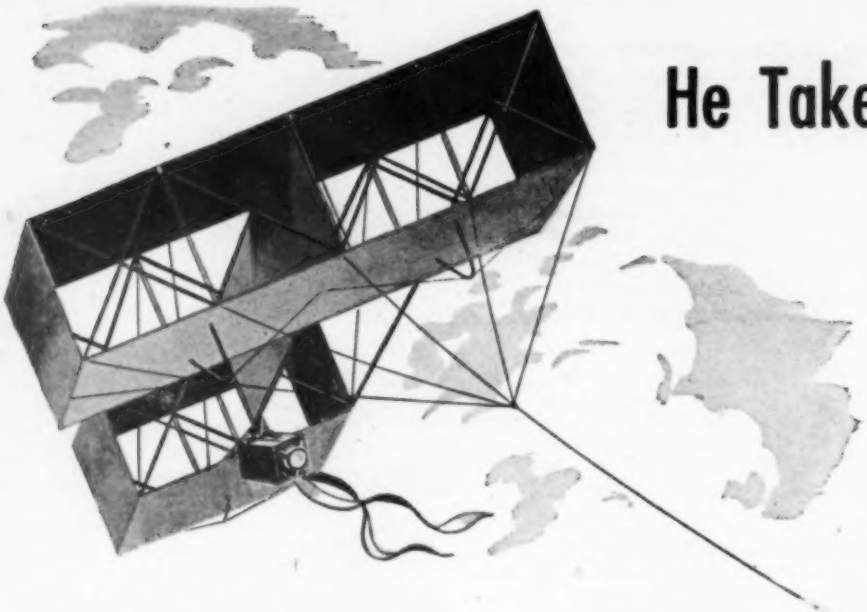
WALKING INTO A WILLIWAW, this Army pilot struggles to make headway against one of the sudden gales common to the Aleutians. The photo, submitted by R. D. Thomas, of Renton, Wash., was taken by flash on infrared film.



WAR ON OKINAWA GOES ON—against mice this time, as the photo above shows. A bag of five is chalked up for this tent in a parody on the well-remembered symbols for downed planes. Alex Chu, a bombardment-group sergeant, took the picture.

FLYING SUPERWEAPON? Would you say that this queer-looking contraption was a jet-propelled life raft, a plane fuselage flying without wings, or some other super-secret, odd invention just released for public view? Perhaps, if you turn the picture upside down and think of reflections on water as you reexamine it, you will be able to tell. It's the conning tower of a German submarine sunk alongside its dock at Hamburg. Note the radar antenna. Lt. Arthur L. Schoeni, of the Navy Department, sent the photo in.



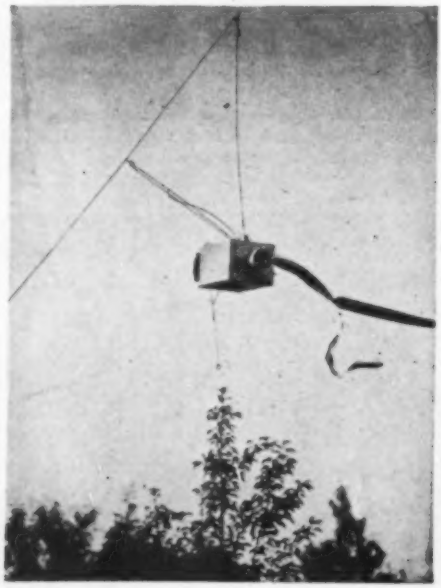


He Takes

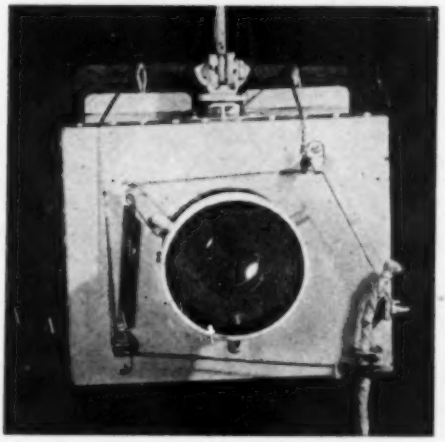
THE old stunt of using a kite to fly a camera aloft has been developed to a fine art by Frank S. Crowell, of St. Albans, N. Y. His homemade aluminum cameras, fitted with fuse-operated shutters, have flown to a height of 2,000′, and Crowell explains that only the hazard of collision with planes has kept him from going higher on days when conditions were favorable for flying kites.

His 13-oz. cameras take 4″ by 5″ or 2¼″ by 3¼″ cut film, and the exposure is usually 1/300 or 1/400 sec. at f/16. A camera may be mounted either on the kite or on two aluminum struts 200′ below, an arrangement that allows the camera to be reset without landing the kite.

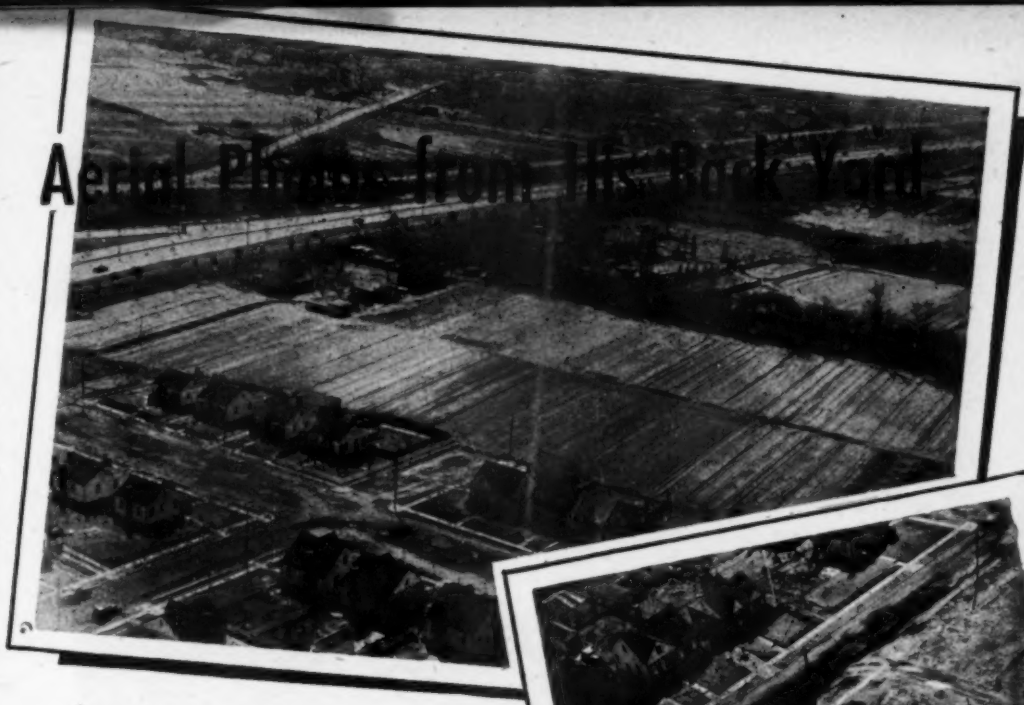
An ingenious signaling system tells



Coming down, left, the camera trails the two warning streamers. In the close-up below, note how the fuse releases two separate signal strings in order.



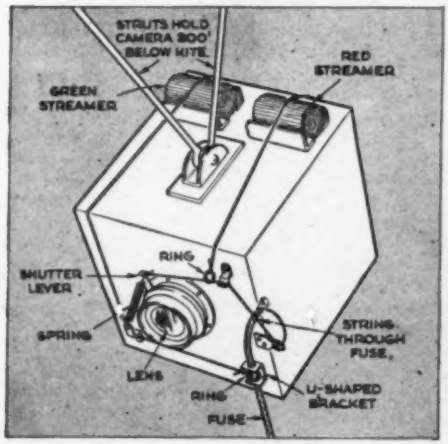
Aerial Photos from His Back Yard



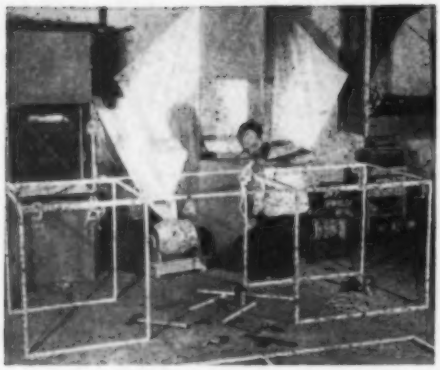
Crowell what is happening aloft. A fuse, made by soaking plumber's cord in saltpeter and water, is cut to burn for a fixed length of time, and the camera sent up. One minute before the fuse trips the shutter, a green crepe-paper streamer is released to trail behind the camera, warning Crowell to hold the kite string for maximum steadiness. The moment the shutter has clicked, a red streamer tells Crowell that he may reel in.

Two of the many aerial pictures that Crowell has taken with homemade cameras. The use of aluminum permits making a cut-film camera weighing 13 oz. Turn the page for pictures of Crowell's kites.

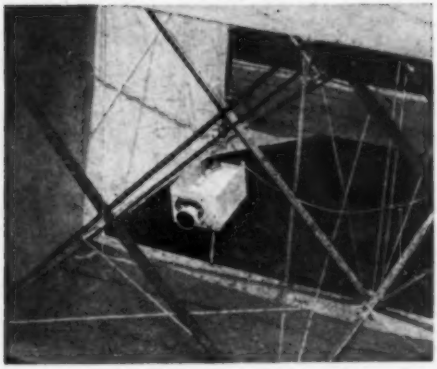
Schematic view of the shutter release and signals. A minute after the fuse frees the warning streamer, it burns through the spring-loaded shutter string.



Below is one of the geared reels Crowell has made. He has about 12,500' of cord.



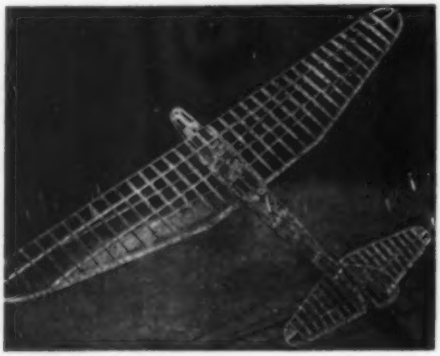
Here Crowell works on the center section of a 15' airplane kite, which is the biggest he has built.



Detail showing one method of camera mounting. The kite is an 8' barrage type from P.S.M. plans.

The 8' barrage kite is designed so that it can be taken apart and rolled up into a compact bundle. Three struts underneath are for protecting the camera during landings. The kite is a reliable performer.

Below, the uncovered framework of an experimental 6' glider-type kite that Crowell designed himself.



The experiment successful, he then set about construction of a 12' model, shown below in progress.

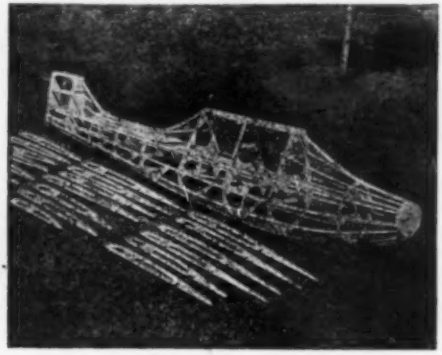


PHOTO IDEAS

DARKROOM DISASTER may come to you, as it did to me one night, if you keep photographic solutions in uniform bottles. Reaching for the developer, I got the hypo instead, and poured it into a loaded film tank. Now I use bottles of different size and shape, as shown above. As an added touch precaution, fine sandpaper is glued to the cap of the hypo bottle.—D. J. BACHNER.

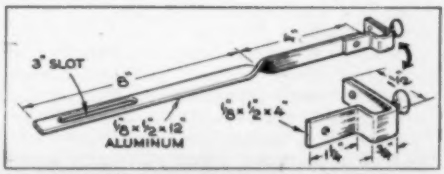
USE OF A LENS SHADE may mean the difference between an excellent picture and one that is not worth printing. A satisfactory shade can be made from one of the inexpensive sparkplug covers that are sold in auto-parts stores. These are a dull black rubber and will not reflect light. With a sharp knife, cut off the small end of the cone-shaped cover at the proper point so that it can just be pressed over the lens.—E. S.

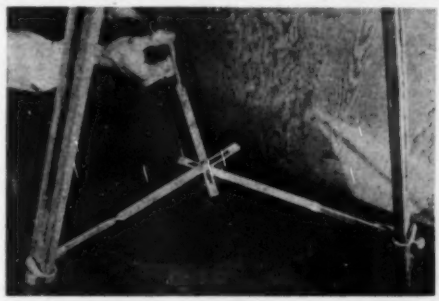
WHEN A FOCUSING CLOTH is used outdoors, even a very light wind will frequently whip it away from the desired position on the camera. This may be avoided by sewing a heavy elastic band to the cloth near one end and then snapping this over the top of the lens board, as shown in the photo above. This will keep one end of the cloth firmly in position even though a strong wind is blowing.—H. LEEPER.

THIS TRIPOD BRACE is sturdy and quickly adjustable. Its parts were cut from a ⅛" by ½" by 48" aluminum strip. Saw off three 12" lengths for the arms and cut a slot about 3" long near the end of each. Then clamp in a vise and bend with heavy pliers to form a half turn 4" from the other end.

Clamps are made from 4" pieces of the aluminum, each being bent as shown and tapped on the outer face of the hook to receive a thumbscrew. To keep the screw from marring the tripod, a flat piece of any thin-gauge metal is riveted to the inside of the clamp. Rivet the clamps themselves loosely to the outside ends of the arms.

A carriage bolt with a square shank near the head holds the brace together, the shank fitting the slot in the upper arm so that the bolt will not turn. The bolt should be threaded along its entire length. A wing nut holds the arms in place and facilitates adjustment.—FRANK CAPORAEL.





Modern electronic servicing requires a test meter that knows all the answers. This article tells you how to make one.

Building a Cathode-Ray Oscilloscope

THE ONE-INSTRUMENT LAB FOR RADIO SERVICING

By JOHN W. CAMPBELL, JR.

NOT long ago, radio servicemen could troubleshoot almost any ailment just by listening to the symptoms. Circuits were —by present standards—relatively simple, and in nine cases out of ten a little sound judgment would quickly suggest the cause of the trouble.

Those days aren't dead yet, but they're dying fast, for two closely connected reasons. The first is that radio engineering has advanced into regions hardly dreamed of a decade ago. Infinitely more complicated circuits offer so many potential trouble spots that it is almost impossible to guess at the cause of poor operation.

Secondly, as an offshoot of better radio design, the public has come to expect quality reception. The old feeling that a radio is all right as long as it plays is giving way to the more critical attitude that a radio should reproduce sound faithfully and well. From a servicing standpoint this means that a cathode-ray oscilloscope has become the keystone of a good radio lab.

A previous article (see P.S.M., Oct. '45, p. 190) discussed some of the jobs that an oscilloscope takes in its stride. Despite the almost superstitious belief that it is a mysterious and fearfully complicated thing, a 'scope is easier to set up than a standard all-wave receiver of comparable quality, and costs about as much to make.

As can be seen from the diagrams on the following pages, the complete oscilloscope involves, essentially, five units: horizontal and vertical amplifiers, sawtooth oscillator, power supply, and cathode-ray tube circuit. The cathode follower which helps stabilize the amplifiers need not be counted as a separate part.

Horizontal and vertical amplifiers are simple repetitions of the same basic circuit. Each is essentially a phase-inverter, push-pull power amplifier such as might be used in any radio receiver. But it is simpler, uses fewer parts, has higher gain, and a type of "high-fidelity" response that is completely beyond the ordinary concept of high fidelity. These amplifiers respond equally to *any* frequency from 20 cycles per second right through the short-wave spectrum at 2,500,000 cycles. The 2.5-megacycle band is handled on a flat characteristic; at 10 megacycles the gain has fallen off somewhat, but still shows considerable amplification.

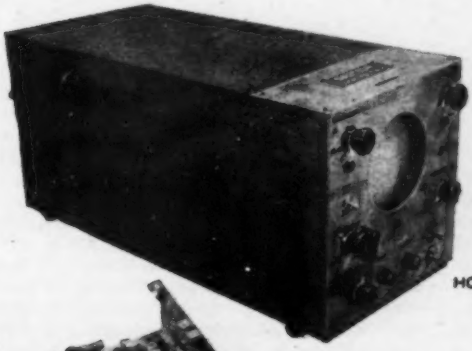
Blocking condensers C1 and C2 are used

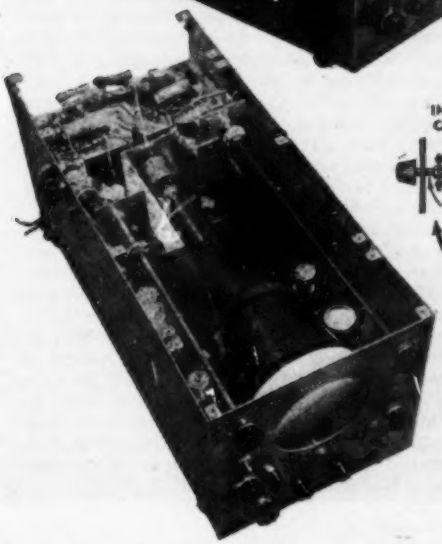
to allow study of A.C. waves on a D.C. line. A composite voltage divider, R1, reduces the effect of stray capacitance. The first half of the 6SN7 is used as a cathode follower to minimize loading of the circuit under test; the other half of the tube is a phase splitter of the cathode-follower type, R5 and R6 being equal. Any value between 1,800 and 2,500 ohms will do, but the two resistors should be accurately matched by ohmmeter tests. This setup assures that the plate and cathode will follow accurately any frequency impressed on the grid, yet never impose a load on the input circuit.

The amplifier stage also follows pretty conventional lines for Class A push-pull, except for one feature. It takes voltage to swing the cathode-ray beam, but almost no power. Instead of using a push-pull output coupling transformer, therefore, resistance loads R10 and R11 are used instead. The 6AG7 is a special type of video power amplifier designed for cathode-ray use. It is unique in that it gives high gain although working into a low load resistance.

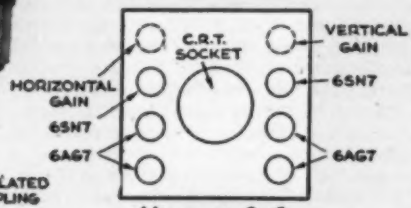
Low load resistance, here and in the phase splitter, is essential to broad band response because of the unavoidable capacity from wiring to ground. Leads, socket pins—everything associated with the circuit—has some unwanted capacity that acts to shunt high frequencies to ground. It's a small capacity—perhaps only 15 mmfd.—but even that becomes important at 2 megacycles, since it represents an impedance of only a few thousand ohms. If we were to use, say, a 50,000-ohm load resistor from plate to ground, much of the high-frequency signal would be shunted by the capacitance. But with a high-power signal developed across 6,000 ohms or less, the slight shunting is simply swamped, and the desired signal blasts through to the cathode-ray tube.

Similar considerations lead to the need for the unusual gain-control system. The full signal is applied to the grid of the first half of the 6SN7, and the potentiometer R3 in the cathode-follower circuit. All potentiometers have some shunting capacity, so low resistance (2,000 ohms in this case) is used

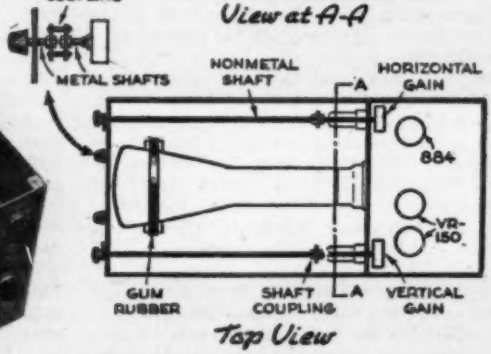




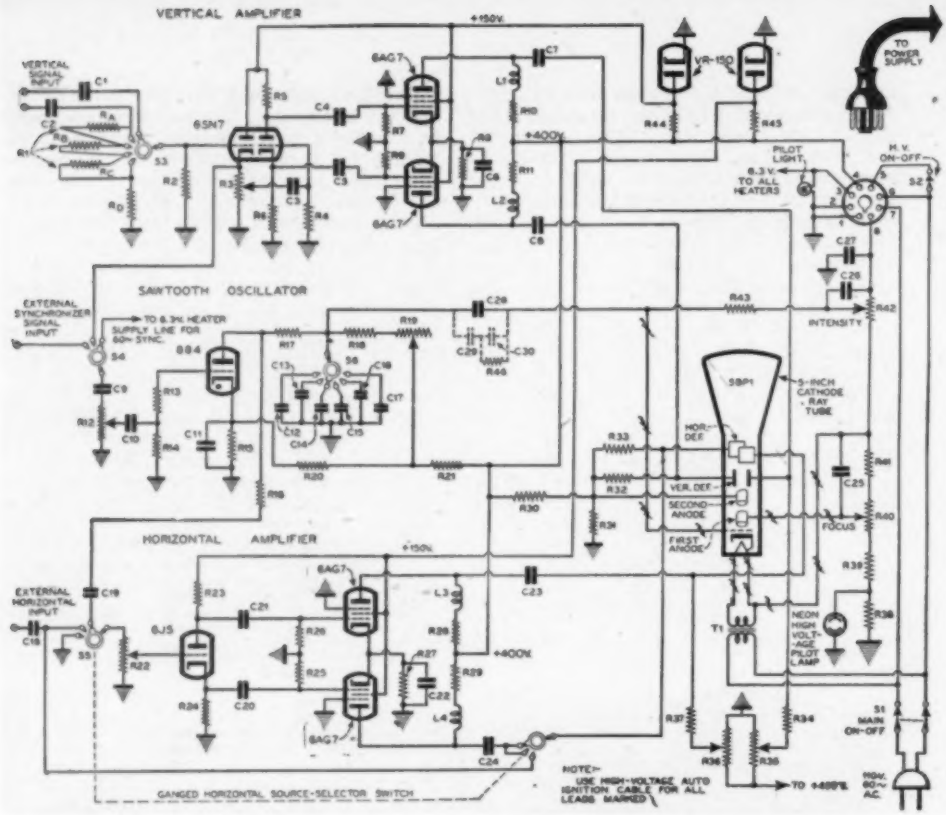
Layout is important on all high-frequency equipment. In order to keep wiring to a minimum, it is necessary to place related parts close together. The drawing shows a recommended arrangement of tube sockets on the subpanel. Note that it differs from the original model shown in the photograph.



View at A-A



Top View



to prevent attenuation of high-frequency signals. But this also means that the cathode follower can't follow signals in excess of about 20 volts. It is in order to boost this range up to about 600 volts that the special voltage divider R1 is used.

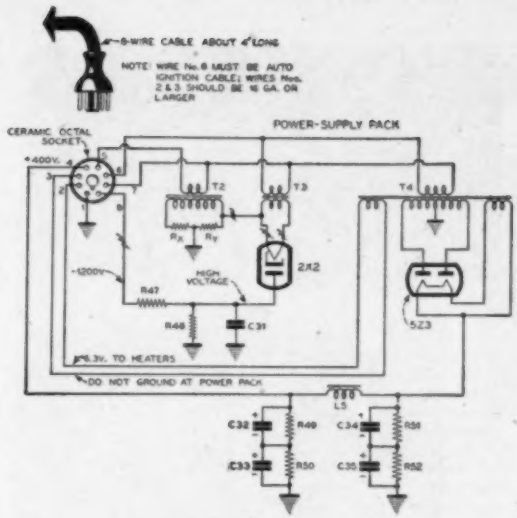
The familiar sine wave represents a graph of voltage plotted against time. To reproduce it on an oscilloscope, we must make the horizontal beam move across the screen at a constant rate. Without this horizontal timing movement, any signal that causes a repeated vertical movement will simply cover its own traces, appearing to the viewer as a straight vertical line.

To give visible motion to the cathode-ray beam, therefore, it is necessary to produce a voltage that will rise at a steady rate, causing the spot to move steadily from left to right, and return from maximum to zero almost instantaneously. A circuit producing such a wave is called a sawtooth oscillator.

In this oscillator, voltage is fed into one of the condensers in the bank C12—C17 through the high resistance of R18 and R19. This voltage gradually builds up across the condenser, and also across the gas-type triode 884. When the voltage reaches a critical value, the gas in the tube breaks down and suddenly becomes an excellent conductor. The full potential discharges through the 884, whereupon the tube relapses into a nonconducting state, and the charge again begins to build up across the condenser.

The frequency with which this trip-hammer discharge takes place depends on several factors: how large a condenser is used (which is why five choices are given), how fast voltage is fed into the selected condenser by varying R19, and how many volts must be developed across the tube before it fires. This last factor is controlled by the tube's grid bias, which is supplied by the voltage divider consisting of R15, R20, and R21, and by signal voltage through S4.

Keeping the beam visible on the fluorescent screen requires that horizontal and vertical movements be synchronized. The trace moves from left to right, jumps back, and starts again from the left. Since the same trace moves both ways, it will be visible on its return trip unless a blanking circuit is used. This consists of R43 and C28; because a 50-mmfd., 2,000-volt capacitor may be hard to get, an alternative circuit is indicated by the dotted lines. In this setup, substitute C30 for C28, and connect it in series with C29 and in parallel with R46.



LIST OF PARTS

All condensers 600 volts unless otherwise noted.

C1, C3, C7, C8, C18, C19, C23, C24, C25, C26: .1 mfd.

C2: 2 mfd., 2,000 volts or highest voltage available.

C4, C5, C10, C20, C21: .25 mfd.

C9, C22: 20 mfd., 25 volts, electrolytic.

C9: .5 mfd.

C11: 25 mfd., 25 volts, electrolytic.

C12: .25 mfd., 400 volts.

C13: .05 mfd., 400 volts.

C14: .005 mfd., 400 volts.

C15: 1,500 mmfd., 400 volts.

C16: 250 mmfd., 400 volts.

C17, C30: 50 mmfd., 400 volts.

C27, C31: 1 mfd., 1,500 volts, oil-filled paper.

C28: 50 mmfd., 2,000 volts.

C29: .001 mfd., 2,000 volts.

C32, C33, C34, C35: 16-mfd., 450-volt, electrolytic filter condensers.

All resistors 1 watt unless otherwise noted.

R1: composite voltage divider, consisting of 3-watt resistors: Ra, 10,000 ohms; Rb, 3,500 ohms; Rc, 1,200 ohms; Rd, 500 ohms.

R2, R4: 2 meg.

R3: 2,000-ohm pot.

R5, R6, R13, R23, R24: 2,000 ohms.

R7, R9, R25, R26, R30, R31, R38: 250,000 ohms.

R8, R27: 50 ohms, 2 watts.

R10, R11, R28, R29: 6,000 ohms, 10 watts.

R12: 5,000-ohm pot.

R14: 40,000 ohms.

R15: 1,500 ohms.

R16, R32, R33, R34, R37: 1 meg.

R17: 25 ohms.

R18: 400,000 ohms.

R19: 5-meg. pot.

R20: 80,000 ohms.

R21: 60,000 ohms.

R22: 2-meg. pot.

R35, R36: 1-meg. pot.

R39: 700,000 ohms, 2 watts (two 350,000 ohms, 1 watt in series).

R40: 500,000 ohms, 2-watt pot.

R41, R43, R49, R50, R51, R53: 100,000 ohms.

R42: 250,000-ohm pot.

R44, R45: 8,000 ohms, 10 watts.

R46: 10 meg.

R47: 20,000 ohms.

R48: 5 meg.

R_x, R_y: To be determined by trial; see text. If T2 is a standard 3,000-volt neon-tube trans., R_x equals 400,000 ohms, 8 watts, and R_y equals 1 meg., 2 watts.

L1, L2, L3, L4: one pie from standard four-pie, 2.5-mh. R.F. choke.

L5: power filter choke, 200 ma., 10 h., or larger.

T1: 115-to-6.3 volt trans.; 5,000-volt insulation.

T2: 115-to-1,000 volts or more.

T3: 115-to-2.5 volt trans.; 5,000-volt insulation.

T4: standard 200-ma. power trans.; 115 to 6.3, 5.0, and 425-0-425.

S1: D.P.S.T. tumbler.

S2: S.P.S.T. toggle.

S3: 5-position selector; preferably low-loss ceramic.

S4: 3-position selector.

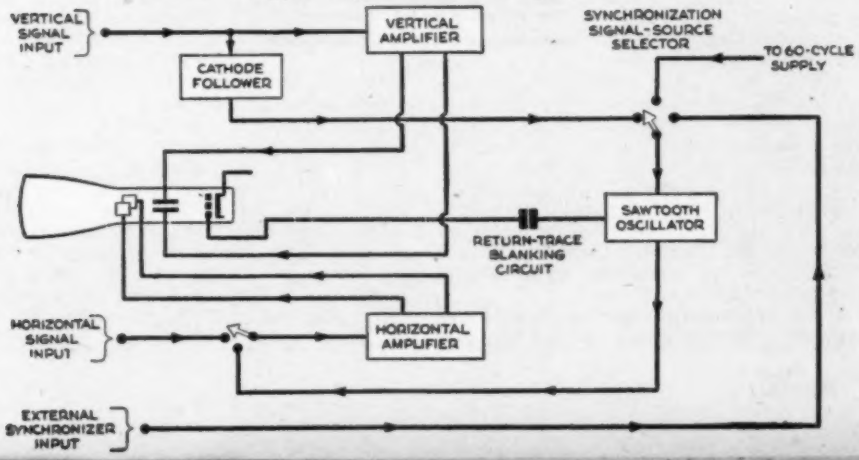
S5: 3-position D.P. selector.

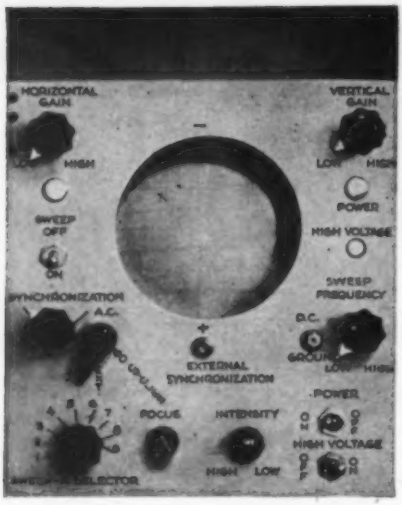
S6: 6-position S.P. selector.

Tubes, sockets, and accessories as noted.

Healthy voltages are needed to drive the spot across the screen, and call for a 200-milliamp. power supply capable of delivering a full 400 volts under load. If you can get transmitter-type filament transformers with 3,000-volt insulation you can save yourself the job of rewinding heater transformers for the 2X2 and cathode-ray tube. This can be done, however, in a single evening's work on two small, standard 6.3-volt transformers. Taking out the core stack, you will find the 6.3-volt winding outermost. Remove this winding, counting the turns. Wind two layers of 5,000-volt insulating cambric over the primary, and, for T1, replace the 6.3-volt secondary. Put another

Block Diagram of Cathode-Ray Oscilloscope





A focused beam without amplification.

Since the oscilloscope is an enormously sensitive test instrument, it needs many controls. A useful panel arrangement is indicated at the left. The three views at the right illustrate the operation of the three amplifiers. Horizontal and vertical signals are shown above; the lower picture shows a vertical signal timed by a horizontal sweep.

double layer of cambric over this, and replace the core stack. The 2X2 transformer (T3) is processed in the same way except that only 25/63 times the number of turns is replaced in the secondary.

The high-voltage transformer can be any convenient one giving 1,000 volts R.M.S. or better. A small neon-sign transformer is likely to be the cheapest and easiest to obtain; it will work nicely in conjunction with a voltage-divider system Rx and Ry as shown. Values of the resistors will have to be determined by trial measurement on the finished oscilloscope. Use different resistors until an output voltage of 1,200 volts negative to ground is obtained across C31 with the high-voltage neon pilot light removed.

WARNING
1,400 VOLTS

High-voltage capacitors can store deadly charges for as much as a week. Do not trust any part of the high-voltage circuit.

Since the busy end of the cathode-ray tube is nearly 18" behind the front panel, the amplifier circuits should be located at the back. Horizontal and vertical-gain potentiometers should be mounted on the subpanel carrying the amplifiers and cathode-ray tube socket. Use long plastic rods to drive the potentiometers from the front panel. Horizontal and vertical input jacks should be placed on the side of the oscilloscope, and the selector switch (S5) for horizontal inputs should also be placed at the side rear.

If the 6AG's are mounted horizontally as suggested by the drawing on page 189, care should be taken to install the sockets so that pins 2 and 7 are in a vertical plane.

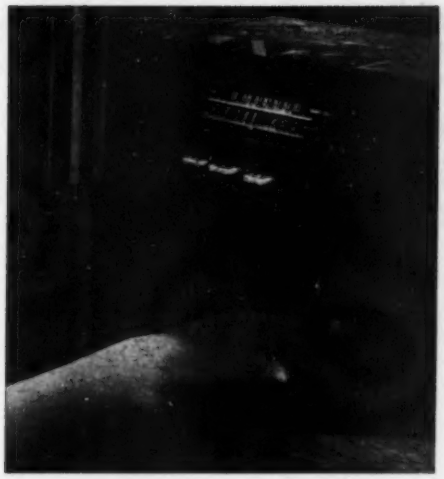
Note that the focusing and intensity control potentiometers (R40, R42) run nearly 1,200 volts negative to ground. But these potentiometers aren't ordinarily insulated to withstand thousand-volt strains—and neither are you. Mount them on a bakelite subpanel and join the shafts with insulated couplings. While the insulation stands up, both you and the oscilloscope are safe. But if it should break down, the metal shaft will cause the cathode to short out to the chassis. It will be an expensive breakdown, to be sure, but at least you'll still be around to make the repair.

Condensers C25 and C26 also run at very high potentials. Make sure they are supported where they can't touch ground. Use high-voltage auto ignition cable for all leads marked with a spark symbol in the diagram.

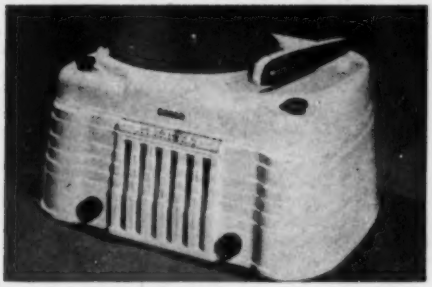
When working on the oscilloscope, its power supply, and especially the high-voltage supply, remember that you are handling sudden death. Electrons are quicker on the draw than you are, so don't depend on your agility to make adjustments with the power on. Engineers, radio hams, and power-line workers live with the stuff because they respect it and never trust it.

They've got the right idea.

News in Electronics

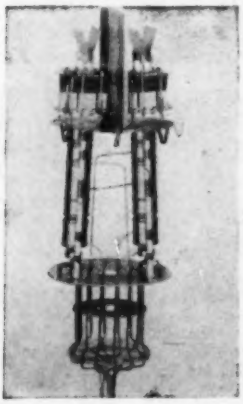


BLACK LIGHT makes dial markings and control knobs of home radios and television receivers glow with color. The light, invisible in itself, consists of ultraviolet rays that activate fluorescent pigments used for the markings. It comes from a miniature tubular bulb made by Westinghouse. The lamp is installed above the dial.

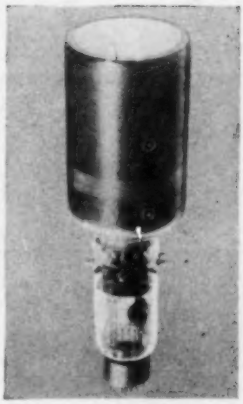


RADIO AND PHONOGRAPH are combined in this small table model built for A.C. operation and available in a plastic cabinet finished in ivory or walnut. An open phonograph turntable on top of the receiver will take 12" records. The new combination set is a product of the Garod Electronics Corporation, of Brooklyn.

CALCULATIONS IN ELECTRONICS are made speedily on a new slide rule designed by Allied Radio Corp., of Chicago, as an aid in solving problems involving resistors in parallel and capacitors in series. Setting the slide aligns pairs of resistors connected in parallel or capacitors connected in series to provide any required value within a 1-ohm to 10-megohm resistance range or a span in capacitance of 10 mmfd. to 10 mfd.

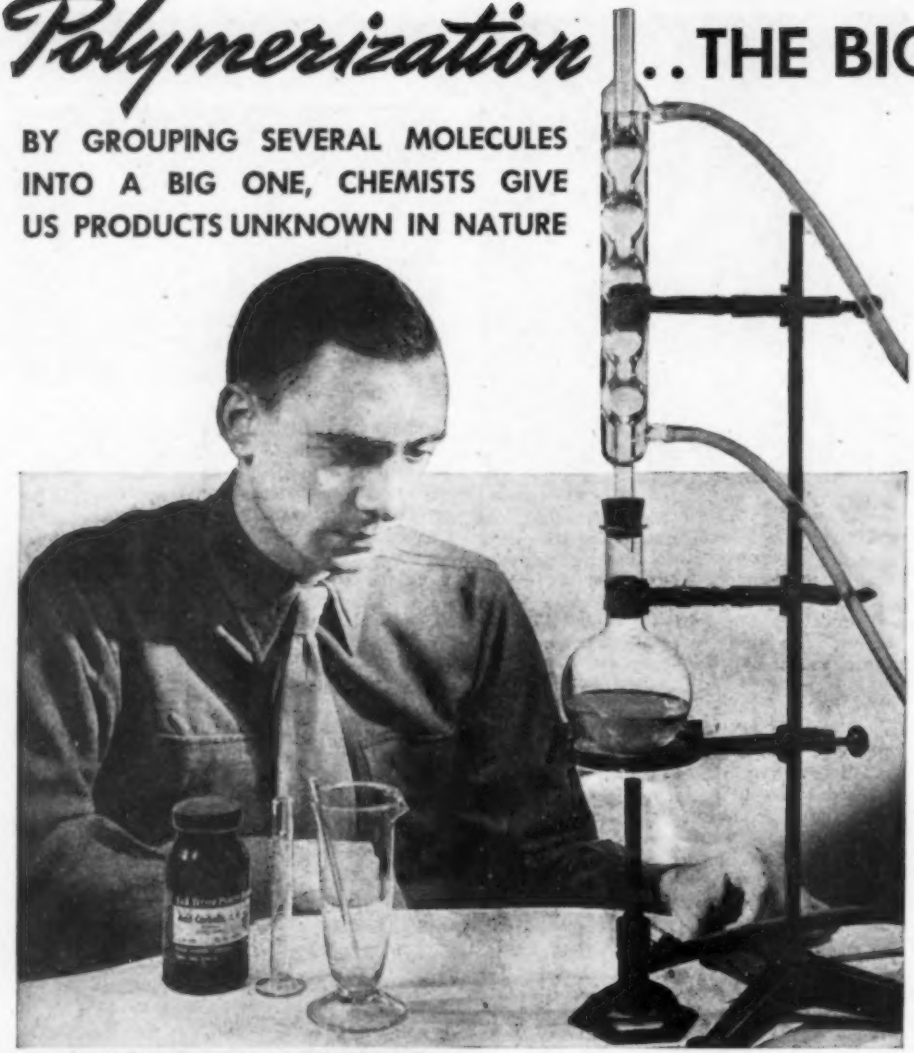


SIMULTANEOUS COMPARISONS on an oscillograph have been made possible with the development of a double-beam cathode-ray tube by Allen B. Du Mont Laboratories, Inc., of Passaic, N. J. Two complete "guns" are built into a single 5" glass tube, as shown at left. They converge on one screen, shown in place on the tube at right, for both simultaneous and superimposed traces, thus multiplying the possible applications in many fields of laboratory and industrial measurement. Deflection-plate leads brought out through the tube wall minimize shunt-input deflection-plate capacitance and lead inductance and prevent interaction between signals.



Polymerization ..THE BIG

BY GROUPING SEVERAL MOLECULES INTO A BIG ONE, CHEMISTS GIVE US PRODUCTS UNKNOWN IN NATURE



One of the first synthetics to come from the chemist's laboratory was bakelite, a product that the home experimenter may polymerize from the materials at the left. After careful mixing, the solution should be gently boiled as above for about an hour. When it thickens to the approximate consistency of molasses, turn off the flame . . .

. . . and pour the solution into a tin lid that will serve as a mold. Then improvise an oven with a reflector, 100-watt bulb, and thermometer, (center) and bake for 1 hour at 50 deg. C. and for 2½ hours at 75 deg. During cooling, your ruby-red disk may crack, but you will have real bakelite.

WORD IN SYNTHETICS

BY KENNETH M. SWEZEY

POLYMERIZATION is the key to a great wonder world of synthetic plastics, rubber, gasoline, and other creations of the modern chemical laboratory. The word may be a bit difficult to pronounce, but it is easy to define. Polymer, its root, comes from two Greek words meaning "consisting of a number of parts." Polymerization, then, means the chemical grouping together of a number of molecules of one substance, or of related substances, to form bigger molecules.

Natural polymers—starches, cotton, silk, wool, leather, and wood—are as old as creation. By studying these, chemists have learned both how to modify such natural materials and to synthesize new ones. Rayon, photographic film, and cellulose lacquers, for instance, are made by taking apart the cellulose of wood and cotton and putting it together in new forms. Bakelite, lucite, nylon, and buna rubber, on the other hand, are examples of chemical synthesis, products different from anything in nature.

Heat, cold, light, mechanical mixing, and catalysts may alone or together take part in this molecule building. The result often is little short of miraculous. Gases lose or gain color, or change into liquids. Liquids become thicker liquids, flexible resins, or even solids. Some substances which ordinarily are highly reactive to heat and chemicals are transformed into heat-stable materials that resist powerful chemicals.

As an introduction to this process, let's try a graphic experiment in which a colored gas becomes a heavier colorless one merely by the application of cold.

Mount a test tube on a stand as shown on page 196, drop in several short pieces of copper wire, and add several ml. of concentrated nitric acid. Close the tube at once with a stopper having a delivery tube leading to the bottom of another test tube standing vertically or on a slant. Place a bit of cardboard over the mouth of the vertical tube to retain the gas that will form.

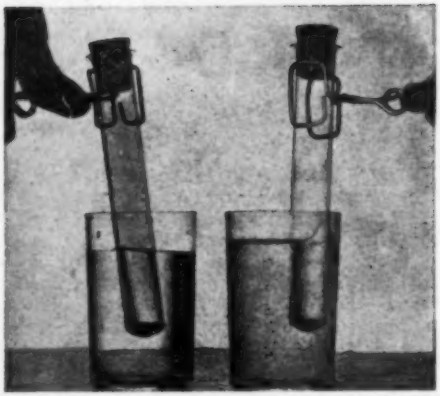
This reddish-brown gas is nitrogen dioxide. *(Caution: Be careful not to breathe this gas.)* When the color indicates that the receiving tube is full of gas, close it tightly with a rubber stopper and collect a second tube of gas in the same manner.

If you now stand one tube in hot water and the other in ice-cold water, you will witness an elementary example of polymerization. The gas in the heated tube becomes darker, more of its molecules breaking down into nitrogen dioxide (NO_2), while that in the chilled tube becomes almost colorless, its molecules doubling up to become nitrogen tetroxide (N_2O_4).

Now put the cooled tube into the hot water and the warm one in the cold water. The reaction is immediately reversed. Both compounds, NO_2 and N_2O_4, have the same elements in the same proportions, but the polymer N_2O_4 is twice as heavy.

Formaldehyde is a gas, but it usually is sold as a solution in water. If you let some of this solution stand in the open in a slightly warm place, a strange thing happens. As the water evaporates, a white solid is left behind. By polymerization, an indefinite number of formaldehyde molecules joined with water and formed the solid—paraformaldehyde. If you heat this solid, it changes directly back to gas.

An important product of polymerization is bakelite, a synthetic resin that is made



Generate two test tubes of nitrogen dioxide by adding nitric acid to bits of copper, as at left. Put one in hot water and the reddish brown gas becomes still darker as more of it forms. But stand the other in ice water and, by polymerization, the nitrogen dioxide (NO_2) becomes colorless nitrogen tetroxide (N_2O_4).

by reacting phenol with formaldehyde. You can easily produce a sample of bakelite at home, and observe the transformation of a water-thin, water-clear, highly reactive solution into a ruby-red, glassy solid that will withstand heat and the effects of most chemicals.

Make your starting solution by dissolving 38 grams of phenol (carbolic acid) in 75 ml. of 40-percent formaldehyde solution. *(Be careful not to spill the phenol on your hands, for it is caustic and poisonous).* Next add about 5 ml. of a 40-percent sodium hydroxide solution to act as a catalyst.

Carefully pour this combined solution into a round-bottomed flask of about 300 ml. capacity, put a wire gauze square under the flask, and mount it on a ring stand. A reflux condenser should be connected to the mouth of the flask to allow steam to escape and return substances with a lower boiling point to the solution. If you lack one of these, an ordinary distilling condenser standing on end can be substituted. Arrange the connections so that water flows into the jacket at the bottom of the condenser and leaves at the top.

Now start the solution boiling gently. The total boiling time necessary will probably exceed an hour, but take a look at the flask every few minutes to observe the strange change that takes place.

If your phenol is absolutely pure, the solution at the beginning will look like water. If it is impure, the solution will have a pinkish tinge. In either case, as the boiling continues, the solution turns a light amber, gradually becoming darker and darker with a trend toward red. The solution also gradually thickens.

Because of differences in conditions of boiling, the time required to complete the reaction cannot be accurately predicted, but must be judged by observation. Keep a constant watch after boiling has continued for about 50 minutes. As soon as the solution thickens to the approximate consistency of molasses, turn off the flame, remove the condenser, and quickly pour the solution into a mold. *(Be sure to turn off the flame as the first step, for the vapors from the flask are inflammable).* Do not allow the solution to boil beyond the point indicated or it will solidify in the flask. As soon as the flask has been emptied, clean it with a brush and a strong solution of trisodium phosphate or of lye.

A tin lid may be used as a mold. If you allow the solution to cool at this point, however, you will discover that you have a resinous substance that melts again on slight heating and dissolves in many organic compounds. To complete the process of polymerization, you must bake the resin several hours at a moderate temperature.

This can be done by putting the mold, with the solution in it, on an asbestos mat and suspending over it a 100-watt bulb in a photographic reflector. A thermometer supported directly over the mold will indicate the approximate temperature. For the first hour, adjust the temperature to about 50 deg. C., then raise it to 75 deg. for the following 2½ hours.

During cooling, your bakelite will shrink and may crack because of internal strains, but it will come out of the mold a shiny, brittle, glasslike disk of ruby red.

A filler such as clay, asbestos powder, or wood dust often is mixed with commercial bakelite to reduce its cost, and pigment may be added to give it a color other than red.

TABLE TRICKS

"SPIRIT MATCHES" appear to pass through each other as you bring them together in your two hands. Hold one wooden match in each hand between the tips of the thumb and forefinger, one in a vertical and the other in a horizontal position, as shown at left, and bring your hands together. Presto! The matches appear to pass through each other, and you show them interlocked!

Dexterity and a little sleight of hand are the secret of the trick. Let the top of the vertical match slip from the tip of the forefinger to between it and the middle finger, where it can be gripped unnoticed. Then it can be lifted up quickly to provide passage.

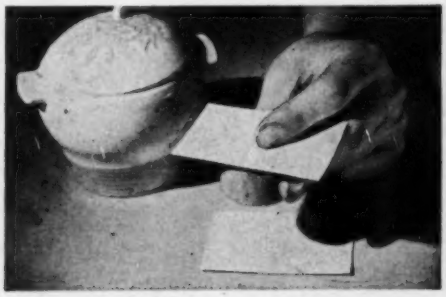
YOU CAN'T LOSE with this card trick, but try it only once in an evening. Write a note and fold it. Then deal out two piles of cards face down.

Announce that this takes concentration and, after silence for a moment, ask someone to choose one pile. When he has indicated his choice, let him read the note. It says: "You will pick the *six* pile." And so he will have, because in one pile there are six cards and in the other the four sixes, which you secretly had on top of the deck.

MONEY CAN BE MADE with a matchbox like this. Show the box with its drawer pulled out far enough for anyone to see it is empty. Close it in full view, open it again, and there is a coin inside!

Of course, the coin was there all the time —under the cover supported by the hidden top edge of the drawer, thus being securely held and completely concealed. In closing the drawer, you allow the coin to fall in.

SUGAR DISAPPEARS by magic done with a napkin ring and two white cards. Place the ring on one card, put a little sugar in it, and cover the ring with the other card. Lift the ring and top card, and no sugar is left. Replace them, pick up both cards with the ring, and return them turned upside down. Again lift the ring and top card, and the sugar is on the bottom one. Unseen is a paper disk pasted over one end of the ring.



FINISHING YOUR WEEK-END TRAILER

By John Gartner

PART II

WHAT with spring getting under way, many people who last month passed up this invitation to build a lightweight trailer may now be ready to change their minds. It's not too late to start construction, but don't try to build your trailer from the information given in this installment alone.

Part I covered the construction of the chassis, walls, and chines. The next step is to stud the sides with ¾" by 1¼" strips of pine, spruce, or hardwood. Locate the studs as shown in Fig. 8 (March), and in the drawings on the facing page, using such fixed positions as floor edge (Fig. 9), door, and window openings as guides. Fasten all studs with glue and collared screws, and place those on the second wall exactly opposite the corresponding members on the first (Fig. 10).

On the outside of each wall you will need a batten strip to cover and reinforce the plywood joint. Make this of ⅜" plywood 2" wide. Using similar ⅜" by 2" strips, build a border around the door opening, leaving a ½" margin except on the hinge side. A door is then cut from the same plywood to fit this frame, and screwed to the ¼" plywood pieces previously cut from the wall to form the door opening. With rubber stripping added, this construction makes a relatively dustproof door.

Mounting the walls to the frame is a job that may require some help from the neighbors. Glue and screw the right wall to the sideboard cabinet over the wheel, and use whatever temporary bracing may be needed to keep the sides perpendicular to the floor. When the location of cross ribs is decided upon, square them across and notch them into the chines.

Plywood will be used for all cabinets, and edges can be given a finished appearance as shown in detail *A*. This detail is dimensioned for ¼" plywood, and has to be adjusted to suit the 3/16" and ⅜" stock used for some of the cabinets.

A sheet of ⅜" plywood 3' wide, fitted across the front and flush against the sides, forms the front of the galley. Fasten it securely to the forward door stud, and to the corresponding stud on the other side. Allow the top of the galley to overlap about 6" into the closet area to provide a shelf for the water tank. Before fastening the top, build a frame of the ¾" by 1¼" stripping to help support the sink. The stove may be treated in the same manner, or it may be let in slightly below the surface (Fig. 11). In the latter case, with a keyhole saw cut the plywood very carefully, and use the cut-out portion as a cover.

Build the front and side of the clothes closet of 3/16" by 4' by 8' gum plywood. Notch a rib into the chines across the top, where it will support the stove vent you have selected. Overhead cabinets, shown in Fig. 13, come next. Determine the shape of the longitudinal pieces by

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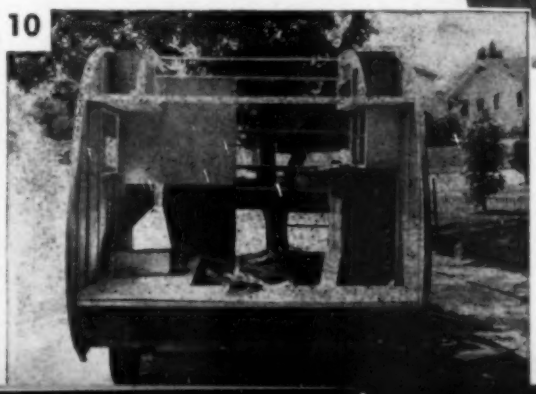
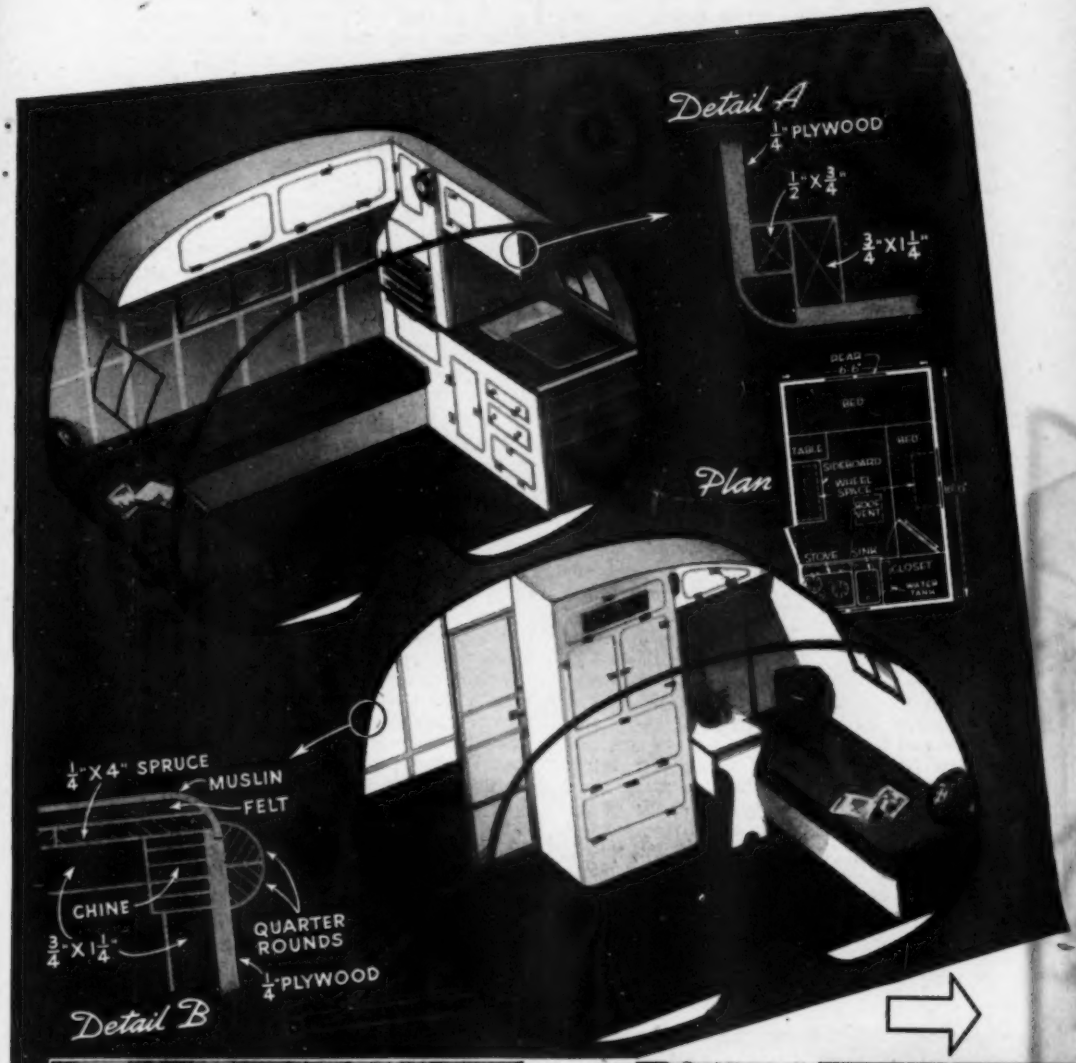
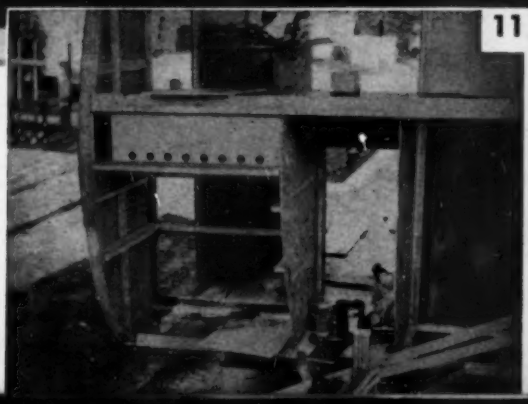
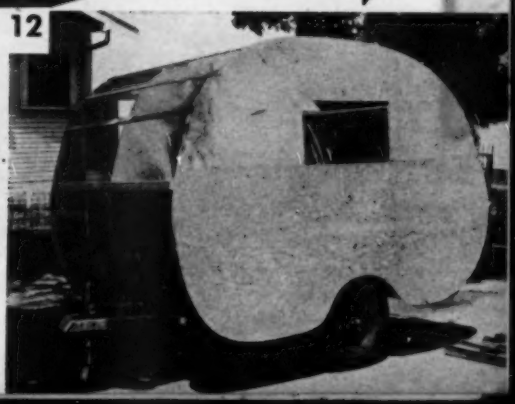



Detail A
1/4" PLYWOOD
1/2" X 3/4"
3/4" X 1 1/4"
Plan
REAR
BED
TABLE
BED
SIDEBOARD
WHEEL SPACE
ROOF VENT
STOVE
SINK
CLOSET
WATER TANK
1/4" X 4" SPRUCE
MUSLIN
FELT
CHINE
3/4" X 1 1/4"
QUARTER ROUNDS
1/4" PLYWOOD
Detail B





marking them off against the corresponding chine curves. Use ¾" stripping for the frames.

To make the side bed, set in a 12" piece of ⅜" plywood parallel to the left wall and about 22" away, using ribbing stock again as a frame. For the second bed, a similar piece of plywood has to be installed crossways at an equal distance from the rear wall. A piece of 3/16" plywood, 24" wide, is used as a top for each bed. Before fastening it to the bed frame, rip the top about 6" from the wall edge and install a length of continuous hinge. This arrangement will enable you to lift the cover without removing the mattress. Crosspieces, notched into the bed supports, will add strength.

Space two ribs across the highest portion of the walls to carry the ventilator you plan to use. Then rib the remainder of the top and ends at approximately 12" centers (Fig. 12). Ribs should be closest at points of greatest bend.

If your friends and family are still gleefully watching you work, call them into service for the next operation. First bevel off the lower edge of the front frame two-by-four. On a stiff cardboard pattern, cut tight notches around the tongue arms, and transfer the pattern to a sheet of 3/16" by 4' by 6'8" plywood. Gum is preferable to the fir panel for this use, since it shows less tendency to raise and weather under strain.

With two people holding the plywood, glue and screw it to the beveled two-by-four. Mark and bore the opening for the sink and icebox waste hoses, and fit the drainpipes before continuing to fasten the wall. Bend the plywood carefully to the shape of the wall, and fasten it to chine and ribs at short intervals (Fig. 14). This front wall should come up to the midpoint of the galley-top rib. Trim any excess beyond this point, and also trim the overhang flush with the sides.

A similar procedure can be followed with the rear wall, which reaches the middle of the window-base rib. Any remaining gaps on the underside or around the tongue can be patched with sheet aluminum.

For the roof and the remainder of the front and rear walls, use ¼" by 4" spruce planks. Fit them smoothly along the ribs (Fig. 15), and secure them with ⅝" screws. Round off the exposed chine corners so that they will not tear the fabric roofing.

Before covering the top, fit the windows and ventilators, but do not install them. Cover the cracks between the roof planks with masking tape and secure a layer of felt padding on top of the planks with canvas cement. Stretch the roll of muslin sheeting tightly over the padded top, and fasten it in place with copper tacks placed about 1" apart. When cutting felt and muslin for the window and vent openings, leave about 1" of excess material which can be tacked tightly into the frames.

After installing these fixtures—preferably with waterproof calking compound—give the top a coat of canvas cement thinned with the solvent recommended for it by the maker. All exposed plywood on the trailer should now be sanded well and coated with a thin mixture of waterproof glue. Three coats of a good spar or plastic varnish will complete the weatherproofing job, and two coats of enamel take care of the appearance. Use two applications of varnish, enamel, or lacquer inside.

For minimum electrical wiring, fasten a female four-way connector to the steel member holding the hitch ball to your car. The four wires lead, through a rubber-covered cable, to the stop light, taillight, battery, and ground. A corresponding male plug is attached to a 3' section of four-wire cable, which goes to the interior of the trailer. Tail and stop-light wires (as well as a ground) are then run to the tail-stop combination that is bolted to the rear wall. Branches from this light are also run to the clearance lights. Battery and ground wires run directly from the connector to three conveniently located interior fixtures. By

13

14

using regular screw-base bulbs and sockets, the same outlets may be made to change over to 115-volt service when available.

Front braces relieve vibration in the tongue and steady the trailer in motion. To make them, cut four 6" lengths of ¾" electrical conduit or brass tubing, fit one on the end of a ¾" dowel, and bolt it through the chine. Cut the dowel to proper length, fit another piece of tubing, and bolt the end to the hitch. Install a duplicate brace on the other side.

With the hitch ball installed and the safety chain bolted to the tongue, you're ready to roll. And if your travels up to now have been limited to hotels and tourist camps, you are about to discover a brand-new freedom in vacation motoring.

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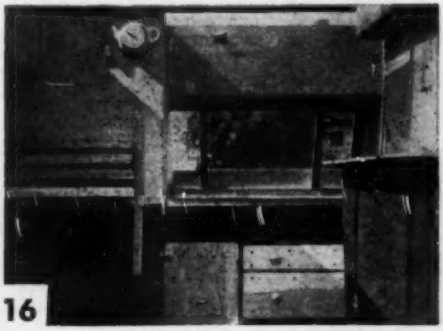

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HOME OWNERS

DINING IN THE FOYER is a convenience in some small apartments, a necessity in others. This attractive, generous-sized table, designed for just such use and exhibited recently at a show staged by R. H. Macy & Co. in New York, folds against the wall and so does not occupy valuable floor space except when needed. The ornamental wall frame into which the table folds is an attractive but inconspicuous addition to the foyer decoration.

COUPLING A GARDEN HOSE is a quick operation with this two-piece accessory, one part of which is screwed permanently on the hydrant and the other into the old hose coupling. Pressing the knurled ring down against a spring releases a series of lugs so they can be pushed over a retaining ring on the hydrant end. The lugs close when the knurled ring is released. The coupling is made by E. B. Wiggins Oil Tool Company, Inc., of Los Angeles.

LIFTING A BUILDING BLOCK can be as simple as picking up a suitcase if you use a metal handle having two ears or lugs that grip inside one of the end holes. It is said that with these metal lifters, two blocks can be carried with greater ease than one can without a handle. The Michigan Silo Co., of Peoria, Ill., manufactures the handles, which are useful also in pushing blocks into place.

TWO PORTABLE GRILLS are ready for the opening of the outdoor-cooking season. The one shown at left, by the Bar-B-Grille Company, of Detroit, has heavy-ceramic, insulated sides held by corner brackets that can be removed to permit flat storage. Its grids are adjustable. The aluminum and stainless-steel cooker below, by the Western Pattern Works, of Los Angeles, has a rotating grid and is available with a stainless-steel cart.

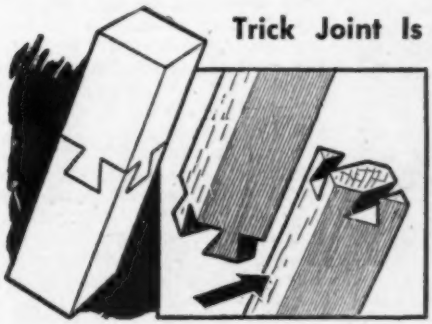
What's Wrong?

How good a painter are you? There are eight errors in the six drawings shown here—three of them in Fig. 3 and one each in the others. Can you find them all and qualify for your next paint job? The correct answers are given upside down below.

ANSWERS

1. This grit is too coarse for this kind of job. No 000 sandpaper is about right.
2. Tube colors should be thoroughly mixed with a small quantity of the paint before being added to the can.
3. (a) The fingers should rest on the ferrule for better control of the brush. (b) Brush strokes should be started some distance from the end. Excess enamel wiped against an edge causes runs and foam. (c) The enamel coat should be preceded by a primer coat and an enamel undercoater.
4. Left-over varnish has already started drying and is sure to contain dirt. It should be discarded and the pan cleaned.
5. Slapping breaks the bristles. Working the bristles by hand is better.
6. Brushing forces paint under the stencil edges and spoils the work. A stubby stencil brush is used with a patting motion, and the paint should be thick, almost a paste.

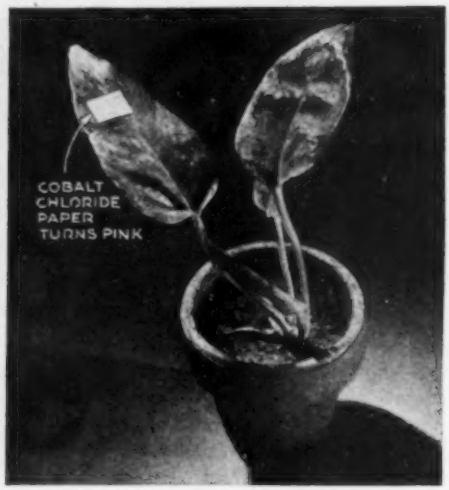
Trick Joint Is Made with Diagonal Dovetails



TWO posts can be joined end to end with a pair of dovetail joints that, when fitted together, give the appearance of a dovetail on each of the four faces. The dovetail tenons and their mortises are cut diagonally across adjoining faces, and in assembly they are slid together from one corner, as indicated in the drawing at left.

For a good fit, lay out the dovetails and mortises carefully. Then saw to split the lines, with the waste outside the dovetails and inside the mortises.—G. H. MILLER.

HOME EXPERIMENTS

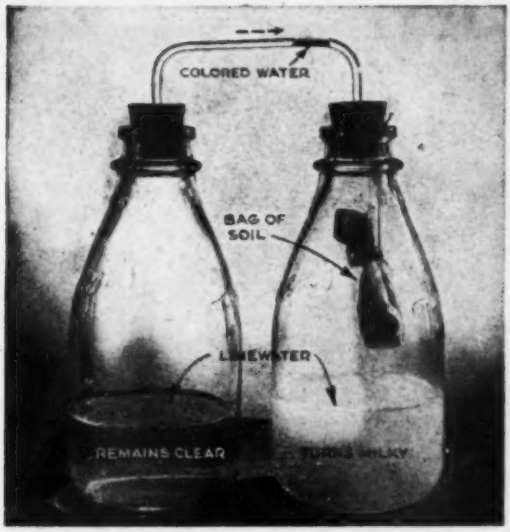


PLANTS FEED on a water solution of minerals drawn from the soil, the excess water being transpired (that is, exhaled) through tiny leaf openings known as stomata. As a demonstration of this process, pour equal amounts of water in two glasses, place a growing plant in one after cleaning all soil from the roots, and pour oil in both glasses to prevent evaporation. The water level in the glass with the plant will gradually fall.

LEAVES EXHALE moisture from both sides, but, as the experiment above will show, this takes place faster on the underside. Make two small pieces of cobalt blue paper by soaking filter paper in a cobalt chloride solution and drying. Fix one by cellulose tape on top of the leaf and the other underneath. Since moisture turns such paper pink, you will be able to see that the leaf "breathes" faster on the underside.

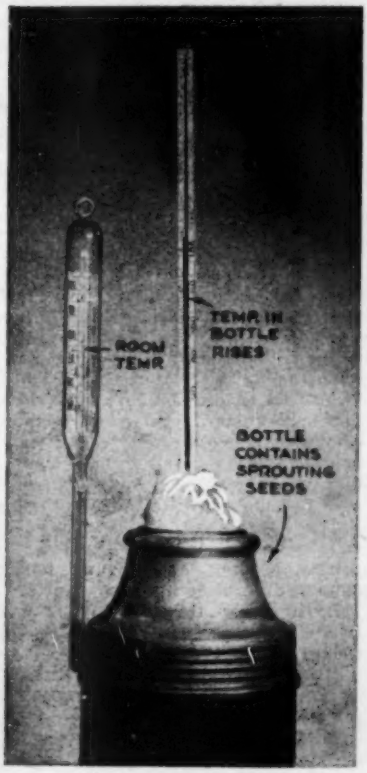
DARK SOIL IS RICH SOIL and light-colored soil is poor soil in most cases—as any good gardener knows. This experiment will enable you to see soil is both rich and dark because it contains moisture and humus. Dig up a handful of dark soil, divide it between two pans so that they balance on a scale, and then take one and heat it gently over a gas flame until no more steam is given off. You will observe that as moisture is lost the soil becomes lighter in color. Return the pan to the balance, and you will find that the soil also has lost weight. Now take the same pan and heat it again, this time turning the flame high and heating the soil as hot as you can. The soil will become still lighter in color and lose still more weight. In the first step, moisture was driven off. In the second, the humus was burned. Consequently, the soil has become arid.

SHOW HOW PLANTS GROW

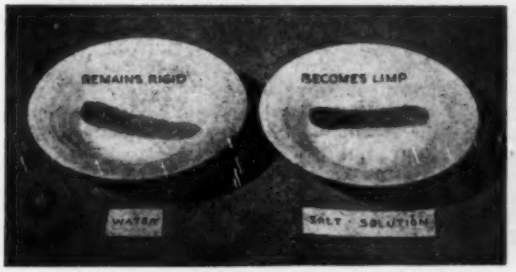


BACTERIA IN SOIL help plants thrive by decomposing the vegetable matter, or humus, on which the plants feed. This bacterial life is constantly breathing in oxygen and breathing out carbon dioxide, as you can readily show. Make some limewater by dissolving slaked lime in water and pour a little in each of two milk bottles. Connect the two bottles, as shown at the left, with a glass tube, in the middle of which a little colored water has been placed to serve as an indicator. In one bottle suspend a cloth bag containing a little fresh soil, and stopper both bottles tightly. After a few days the limewater in the bottle containing the bag will turn white, indicating the presence of carbon dioxide. Because the soil bacteria have used up oxygen in the process, the drop of indicating liquid in the tubing will move slightly toward this bottle.

SEEDS GENERATE HEAT while germinating. You may prove this as indicated at the right. Place a handful of seeds such as beans or peas in the vacuum bottle, fix a thermometer so that its bulb is among them, moisten the seeds slightly, suspend a small open vial containing a little potassium hydroxide above the seeds to absorb carbon dioxide, and stuff the mouth of the bottle full of absorbent cotton. In an hour or so, the temperature of the seeds will rise well above the room temperature.



FRUITS AND PLANTS ARE RIGID chiefly because their cell walls and protoplasmic membranes are distended by fluid. Decrease the amount of fluid the cells contain, or kill the protoplasm, and the fruits or plants become limp. The fresh cucumbers shown below illustrate this, for the one at the right loses fluid by osmotic action to the salt solution. Boiling also will make a cucumber limp by killing the protoplasm and breaking down the cells.



I Built This Radio Bookcase

By THOMAS W. KELLEY

WHEN construction is kept simple to avoid intricacies such as curves, moldings, and tenoned joints, even ambitious projects can be tackled with little more than a square, plane, handsaw, screwdriver, and gluepot. I found our only bookcase becoming so badly overloaded that it was getting sway-backed, and I didn't have access to a home workshop in the small apartment we occupied. Our old radio cabinet was also on the disreputable side, so I drew a deep breath and decided to build a piece of furniture to care for both books and radio.

The result, shown here, indicates what can be done without power tools. But, of course, with a well-equipped home workshop you can save much time in the process.

I was lucky enough to find 16" boards for the sides, bottom, and cabinet tops, but there is no reason why these pieces could not have been made with 8" stock joined by dowels or hidden cleats. The boards were planed true, sawed to size, rough sanded, and assembled with butt joints and flathead screws, the cabinet tops and second shelf being notched to fit atop the steps in the sides, thus gaining extra support.

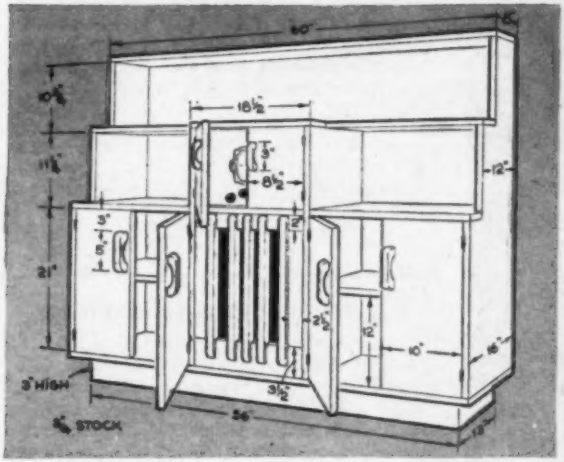
Ample space was allowed for the radio chassis—or for a new one should we acquire it. The chassis was to be mounted off center because its dial and tuning controls were on one side. In front of it was placed a new panel with openings cut from a pattern taken from the old cabinet.

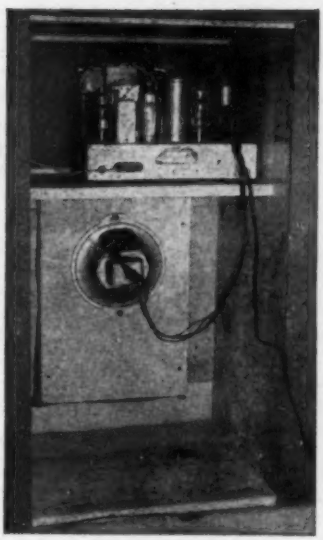
A frame was made to fit inside the opening for the radio speaker, with the top 2" wide, the sides 2½", and the bottom piece 3½". To the frame were attached the sections of the speaker grille. These five 1" by 1⅛" by 20" pieces were notched at the ends for a 2" overlap at the top and one of 2½" at the bottom.

Doors were cut from quartersawed boards to fit the three cabinet openings (¾" plywood would have been fine) and were hung on butt hinges. They were equipped with knobs cut from ¾" by ¾" stock and with friction catches. A small wooden stop was glued behind each catch. The back was covered with wallboard except for the radio compartments.

All nail holes, knots, and other indenta-

with Hand Tools





tions were filled with wood putty, and the entire case was sanded smooth, first with coarse and finally with fine sandpaper. Two coats of shellac were applied, with a sanding after each, followed by a light cream-colored enamel undercoat. Peasant designs were then painted on freehand with oil colors mixed in clear varnish and turpentine. A thin coat of clear varnish was next applied and rubbed to an antique finish, and a final coat of clear varnish put on over all.

The radio chassis was then lined up, mounting holes drilled in its compartment, and bolts inserted. Cloth was tacked on behind the grille, the speaker being mounted over a hole cut in a piece of plywood.

Desk, Cabinet, and Shelves Are Combined in Room Corner Unit

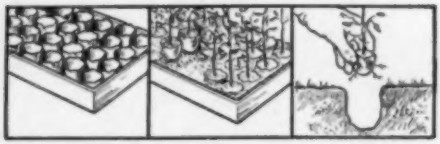
BUILT-IN furniture, long popular in homes, is never more effective than when it ties together the decorations of a room. The piece shown here is strictly utilitarian, but it combines service with the beauty of the simple lines associated with modern design. It is painted to match the room woodwork and the screening enclosing the radiator under the desk. Involving no difficult construction, it's an easy job with hand tools.

Aside from its application to a playroom, as shown here, the basic design could be adapted for use in a study, library, or sewing room. Its specific dimensions will depend on many factors—the age and height of the person who is to use the desk, the kinds and sizes of articles to be kept on the shelves and in the cupboard, the length of the wall space to be filled and so on. A simple scale drawing, which you can make on ruled squares will help you fix on the best proportions.

In general it will be found adequate to make the shelves of 8" stock and the cupboard 10" to 12" deep, while the work space in front of the window could be about 20" deep by 26" long. Incidentally, if this unit is to be used as a desk or worktable, it will be well to design the piece so it will come near a window—WILLIAM FREEMAN.

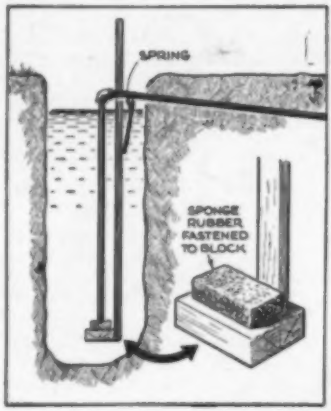
King-Size Rhubarb and Beets

VEGETABLES come large in Australia, as evidenced by the rhubarb and silver beet in the photo at left. Silver beet is described as a spinach with a heavy root. The plants weighing down the child were in the Cheltenham Horticultural Society show.



Eggshells Protect Seedlings

ONE method of seeding flats to protect the tiny roots from cutworms and fungi is to plant the seeds in eggshells, as above. The shells are filled with soil, seeded, and put in the flats, which are then filled evenly with soil. Shells are transplanted along with the seedlings, and they soon rot away in the ground.—DAVID B. CLAPP.



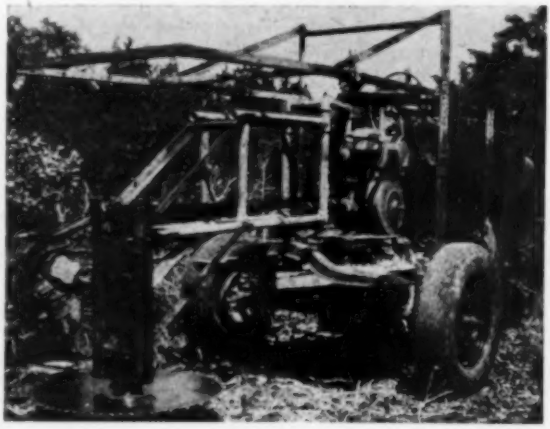
Well Pipe-Line Cutoff for Making Repairs

WATER from a deep well into a gravity-flow pipe line can be shut off at the source with a rubber sponge on a wooden block, as shown above, to facilitate repairing leaks. The sponge block is nailed to a long stick, which in turn is attached with a spring to the pipe to hold the sponge against the end of the pipe.—RALPH S. WILKES.

Motorized Saw Clears Trees and Brush

MOUNTED on a turntable on a Model-A Ford chassis, the circular saw shown below can be swung to either side to cut down trees or brush. Except for a 6-hp. air-cooled auxiliary gas engine that powers the saw, the entire unit was built by C. M. Canady, of Liberty Hill, Texas, from old automobile parts and scrap iron.

The chassis was coupled up short, a supplemental transmission was added for slow speeds, and a tricycle steering gear was built and installed to make steering easier. Both the saw engine and saw carriage were mounted on the table, to which was geared a second steering wheel for turning from side to side.



IT'S A GRAND FEELING, TOO, WHEN YOUR CAR IS CUSHIONED WITH MARFAK CHASSIS LUBRICATION

With ordinary grease . . . you're taking the road shocks again after a few hundred miles.

Marfak stays on the job hundreds of miles longer — means more velvet smooth *riding.*

THERE are many good reasons why your car acquires that "cushiony" feeling when you specify *Marfak* Chassis Lubrication.

Most important reasons are the adhesive and cohesive qualities that make *Marfak* resist wash-out, jar-out and squeeze-out. And because *Marfak* sticks to the job, that "cushiony" feeling lasts miles and miles longer.

Marfak clings to bearing surfaces and seals out dirt and grime.

That's why it's a grand feeling when your car is "cushioned" with *Marfak* Chassis Lubricant. See your Texaco Dealer today, and say: "*Marfak*, please!"

You're welcome at

TEXACO DEALERS

FIRE-CHIEF GASOLINE

SKY CHIEF GASOLINE

HAVOLINE AND TEXACO MOTOR OILS

MARFAK LUBRICATION

THE TEXAS COMPANY

Tune in the TEXACO STAR THEATRE with JAMES MELTON Sunday Nights ★ CONSULT NEWSPAPERS FOR TIME AND STATION

A Nicholson 12-inch Flat Second Cut File
Is being used here in filing a punch die.

TOOLMAKERS' files must be right for the job

Dies, jigs, fixtures, gauges, cams, trips, holders, spindles—the closer the tolerances to be worked out by hand, the more careful should be the selection of files. . . . Second Cut files instead of Coarse or Bastard; Smooth instead of Second Cut; Swiss Pattern or Special Purpose instead of Regular types.

Nicholson is virtually a "file engineering laboratory"—an establishment where the requirements of files for different purposes and metals are a never-ending study. Every day presents new opportunities for tool, die, and other work-bench specialists who *know their files.*

THE MILL SUPPLY and HARDWARE houses selling Nicholson or Black Diamond files are good places to learn about and obtain *the right files for EVERY job.* And Nicholson's "FILE FILOSOPHY" is a 48-page book worth writing for.

NICHOLSON FILE CO., 19 Acorn St., Providence 1, R. I.
(In Canada, Port Hope, Ont.)

NICHOLSON FILES *FOR EVERY PURPOSE* NICHOLSON U.S.A. MADE IN U.S.A.

Brightest Commercial Light Bulb

THE world's most brilliant commercial lamp (above) is a product of the Westinghouse Lamp Division. A 1,000-watter with a tubular bulb, its yellow-green light of 60,000 lumens comes from a mercury-vapor arc about as thick and twice as long as a cigarette.

With three times the light output of a conventional 1,000-watt incandescent bulb, the new lamp was designed primarily for illuminating high-ceilinged factories, baseball diamonds, and other large areas. It is also adapted to the lighting of arc-welding booths. Unlike most high-intensity mercury lamps, the new bulb can be burned in any position, but, like all arc lamps, it operates with a step-up transformer, and has a current-limiting device called a reactor. It generates less heat than a water-cooled lamp.

New Oils Function Efficiently In Both Extreme Cold and Heat

OILS that continue to flow at 121° below zero Fahrenheit and yet neither oxidize nor sludge at 302° above zero have been developed in the General Electric Company laboratories at Schenectady, N. Y.

The new oils, of the silicone oil family, are adapted for use as hydraulic fluids in aircraft systems and as lubricants in watches and clocks. They are valuable as insulators in electrical apparatus.

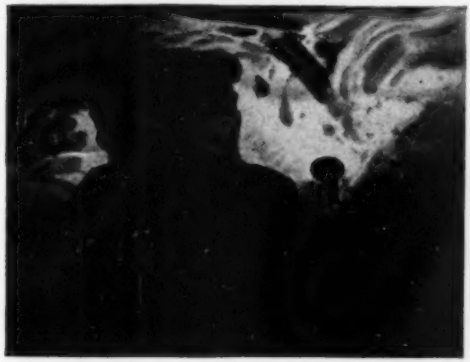
Silicone rubbers have been produced that do not decompose at 400° F. or harden at 67° below zero, and maintain their elasticity under load for long periods at the high temperature of 302°.

How to Fight the Menace of FIRE

...A Wet Towel and a Flashlight may save your life!
—says the National Safety Council

1 Fire is always dangerous—especially dangerous at night, when you may be asleep. And most fires *do* occur at night! If you smell smoke, reach for your "Eveready" flashlight *first. Feel doors before opening them,* for a single breath of fiery air can kill you! If a door is *hot,* don't open it!

2 Wet a towel or cloth; cover your face and arms. Close doors to reduce drafts that may fan the flames. If heat is severe, remember that heat rises—*crawl!* If trapped on upper floor, make a rope of bedclothes. As a last resort only, throw out a mattress and jump down onto it.



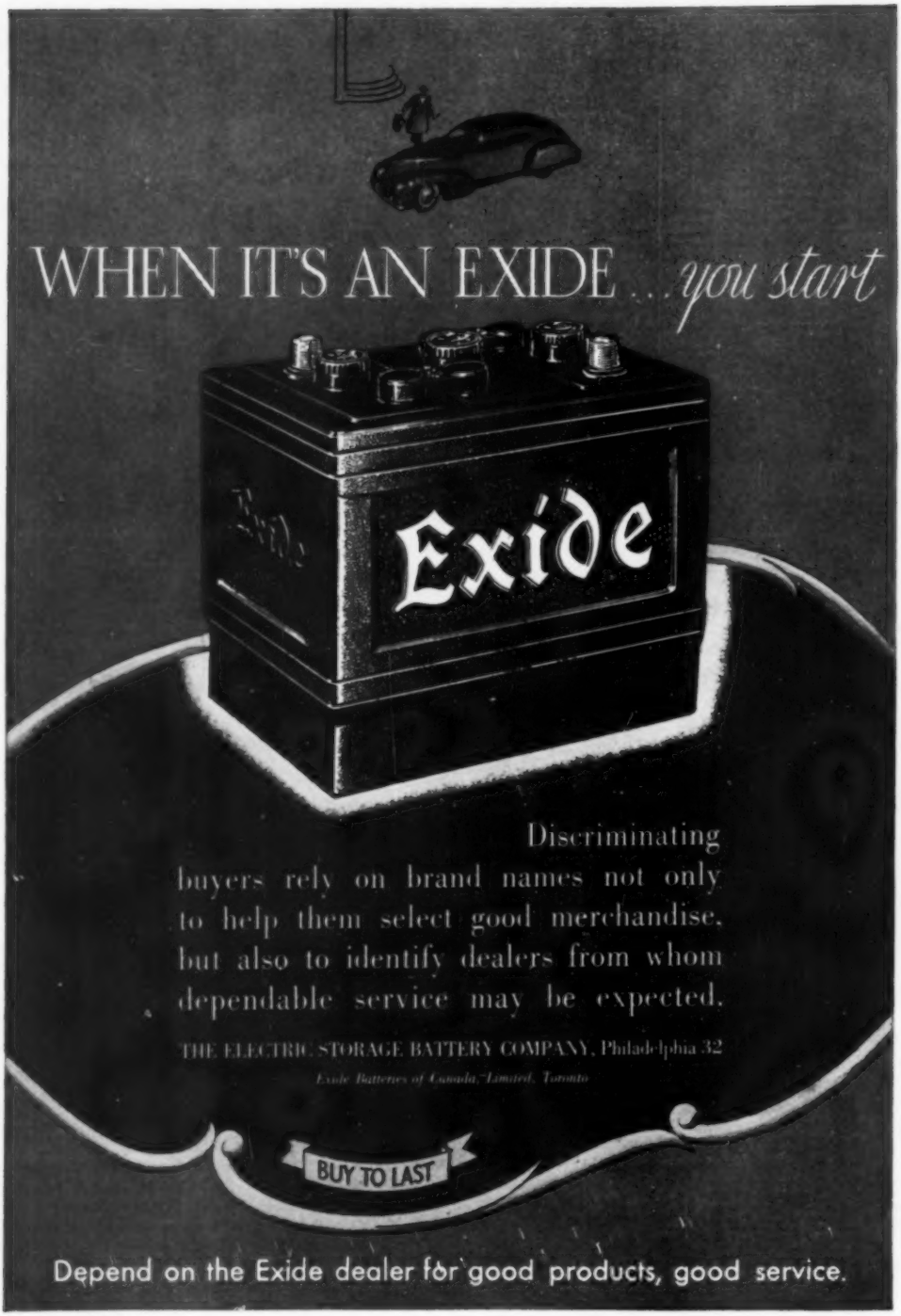
3 To avoid danger, you have to *see* it—so keep your flashlight with you until you're safe! Watch for collapsing ceilings... But the best way to avoid fire is to *prevent* it! Your flashlight—with fresh "Eveready" Batteries—gives a much *better* light than matches or a candle, and it's much *safer* too!

4 To help fight fire—or for *any* flashlight need—rely on "Eveready" Batteries. Ask your dealer for them by name. The days when you had to accept "second choice" batteries—or none—are past. "Eveready" Batteries have no equal—that's why they're the biggest-selling flashlight batteries in the world!

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
UCC

EVEREADY
TRADE-MARK

The registered trademark "Eveready" distinguishes products of National Carbon Company, Inc.


WHEN IT'S AN EXIDE ... you start
Exide
Discriminating buyers rely on brand names not only to help them select good merchandise, but also to identify dealers from whom dependable service may be expected.
THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto
BUY TO LAST
Depend on the Exide dealer for good products, good service.

"RADAR REPAIR *on the double!!*"

• Peace now flies the sky-ways of the world. . . . Who keeps these giants flying? You, the skilled technician. . . .

• The Army Air Forces rely upon men on the ground to keep men in the air. Right now there is a *real need* for radar technicians, control tower operators, teletype operators and repairmen, radio operators, repairmen and mechanics. These are the men who stand watch over the heart, eyes and ears of our planes. . . .

• If you are between the ages of 17 and 34 and have an electrical or mechanical background, the Army Air Forces needs you. Enlist today.

• You will be sent to the finest aviation training schools in the world. Radar, radio, electrical systems, the latest internal combustion engines and jet propulsion are your new fields. And you will *earn as you learn.*

• A private starts at $50 per month but skilled technicians can earn as much as $200 per month. You are fed, sheltered and clothed. The finest medical and dental care is free. . . .

• Enlistments are for 1½, 2 or 3 years. You can choose your branch of the service and your overseas theater if you enlist for 3 years. There is 20% additional pay for overseas service and 50% for flight time. You get a 30-day paid furlough every year. There are generous family allowances for the dependents of men who enlist before July 1, 1946. After 20 years of service you can retire at half pay, increasing to three-quarters pay after 30 years of service.

• If you are physically qualified, enlist today. Find out more about this great opportunity to fully develop and use your skills in the Army Air Forces. Go to your nearest Army Recruiting Station today.

SEE THE JOB THROUGH

U. S. Army

BE A

"GUARDIAN OF VICTORY"

U. S. ARMY AIR FORCES

Q. Why is this the WORLD'S MOST CAREFREE WATCH?

A. CROTON AQUAMATIC WINDS ALL BY ITSELF!

Just imagine the sheer delight — the gay and happy *carefree* feeling that comes with wearing this 17-jewel master timepiece! Croton Aquamatic is one watch you don't have to "baby". You just strap it to your wrist and forget it, except to consult it with absolute confidence whenever you want to know the time. You *never* have to wind your Croton, because it winds itself just by the natural motions of your wrist as you wear it!

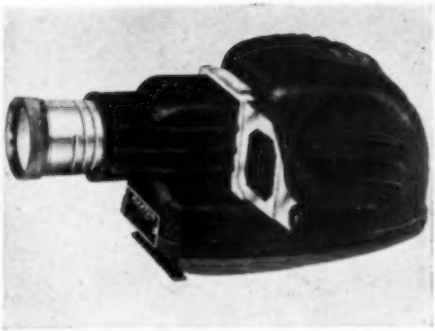
It's CERTIFIED Waterproof!

You can go right ahead and wear your Croton Aquamatic when washing, bathing, swimming—because it's completely waterproof. Wear it in any kind of water—hot, cold, fresh or salt. And that's not *all!* This 17-jewel beauty is *dust-proof*, doesn't tarnish, and the glass crystal can't break. It has a sweep-second hand, radium dial, waterproof strap. Whenever it's gift-time, remember that Croton Aquamatic will make him very happy. The price? *Only* $49.50.

P. S. If not now available at your dealer, write for Free Booklet. Croton Watch Co., 48 W. 48th St., N. Y. 19

Croton SELF-WINDING

WATERPROOF AQUAMATIC



New Projector Has Carrier That Ventilates Slides

DESIGNED for either slides or film strips, the Marton Projector is equipped with a new type of carrier that permits ventilation of the slide while it is being projected. The projector, which is marketed through Associated Photo Products Co., of New York City, does not necessitate the use of heat-resistant filters. Its illuminating system employs a 100-watt bulb and is said to give a brilliance ordinarily requiring 150 watts.

"Flying Elevator" Tests Angles Of Glide-Path Radio Signals

DESCENDING foot by foot, hovering at various levels when necessary, a helicopter at Wright Field has been used to calibrate the radio signals of the instrument-approach and glide-path landing systems. The glide path intersects a radio signal sent out to "home" the plane from a point 15 miles beyond the runway, and provides a beam on which the pilot can descend through an overcast for a blind landing.

The "flying elevator" has enabled engineers to find out how far above or below the glide path signals could vary before indicating deflection.

Model Builders Attention!

Actual Size V-Plug

	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Sillment sealed. Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One piece construction.

CHAMPION

SPARK PLUG COMPANY • TOLEDO 1, OHIO

Here's why most Farmers prefer Champion Spark Plugs

THEY'RE DEPENDABLE!

The American farmer is by far the most proficient user of cars, trucks, tractors and stationary engines. As such he is a qualified expert on engine performance.

Survey after survey has proved that farmers prefer Champion Spark Plugs in overwhelming majority—powerful evidence that you can depend on Champions for better performance in every engine. Champion Spark Plug Company, Toledo 1, O.

FOLLOW THE EXPERTS . . . DEMAND DEPENDABLE CHAMPIONS FOR YOUR CAR

The NEW sectional canoe

Take it along on *every* trip! The Linkanoe assembles in less than 10 minutes. Strong moulded sections clamp rigidly together...no tools needed.

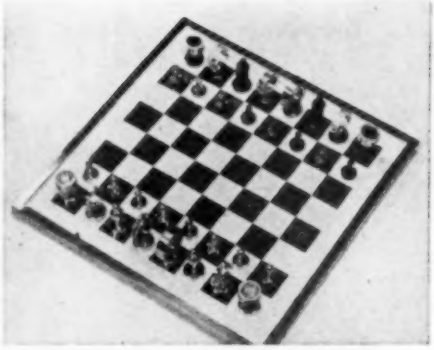
LINKANOE is built by the makers of the famous Link Trainer. Designed by sportsmen who fly into the North Country, carrying their craft by plane. Under rigorous tests, Linkanoe has proved sturdy, superbly balanced, easy to handle. Packs into two, easy-to-carry bags. Goes in luggage compartment of car, by plane or pack horse.

Always have LINKANOE with You! Plan your vacation around this easily portable craft. It's worth a lot to have your canoe *when* and *where* you want it. Write today for illustrated folder and prices.

• • •

DEALERS: *Applications now being considered... send for details!*

LINK AVIATION DEVICES, Inc.
BINGHAMTON, N. Y.



Ball Bearings Versus Roller Bearings Form This Striking Chess Set

BALL and roller bearings are employed as the pieces and pawns of a striking chess set produced by the Schirgun Corporation, of New York City. Ball bearings are used for all the men on one side and roller bearings for those on the other.

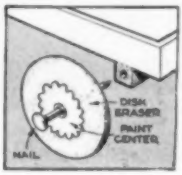
In each case, the complete bearing makes the king. When the outer ring is removed, the remainder resembles a crown and represents the queen. Bishops are provided by mounting two rollers or two balls, one upon the other; the cages that hold the rollers or balls serve as knights; and the inner rings are mounted to represent castles. The rollers or balls themselves serve as pawns.

Knurling Tightens Loose Bushings

IF TOO much metal should be removed accidentally when a bushing is being machined for a drive fit, the error can be remedied by knurling the outside of the bushing. The knurling will raise the surface of the metal sufficiently to give the tight fit that is desired. This same method may be employed when it is necessary to tighten up bearings that have worked loose.—W. TEEBOON.

Disk Erasers Serve as Toy Wheels

DISK erasers provide practically ready-made rubber-tired wheels for small toys or model airplanes. If the diameter of the eraser is too great for the wheel required, the outer edge of the rubber can be cut and worn away. A coat of paint will hide the printing on the disk at the center of the eraser.—R. P. S.



Tough...

BUT OH SO GENTLE

When you install new piston rings, it will pay you to get Hastings rings. They *stop* oil-pumping, *check* cylinder wear and *restore* engine performance . . . Ask your motor specialist.

HASTINGS MANUFACTURING COMPANY
HASTINGS, MICHIGAN
Hastings Ltd., Toronto

HASTINGS STEEL-VENT
PISTON RINGS

TOUGH ON OIL-PUMPING GENTLE ON CYLINDER WALLS

Drillet Box Jig Saves Up to 75% of Jig Body Expense and Labor!

The six-sided Drillet Box Jig above and at right has a range of 125 different sizes, making it possible to accommodate all sizes up to 6" capacity—for drilling, reaming, counter boring, counter sinking, spot facing, tapping, etc.

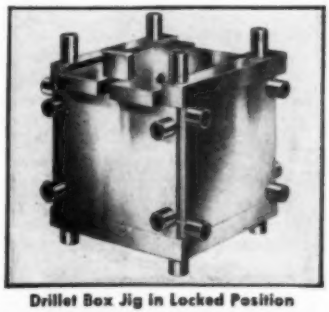
The Drillet Box Jig makes special tool design for drill jig unnecessary. Saves up to 75% of the time and cost of building a jig body. By merely turning thumbscrews and raising leaf, parts may be quickly loaded or unloaded. The jig may be used on all six sides, taking advantage of its full capacity.

Another useful product is chewing gum. You can enjoy chewing Wrigley's Spearmint Gum even while your hands are busy. The pleasant chewing helps to steady you—helps keep you alert and on your toes when you're doing a monotonous job.

Besides the satisfaction chewing gives you, it helps keep your mouth moist and fresh so you naturally feel better—and feeling better you work better.

Scores of industrial plants report that they have stepped up their workers' morale and efficiency by making chewing gum available to them.

You can get complete information from The Chicago Drillet Corporation, 920 S. Michigan Ave., Chicago 5, Ill.



Drillet Box Jig in Locked Position

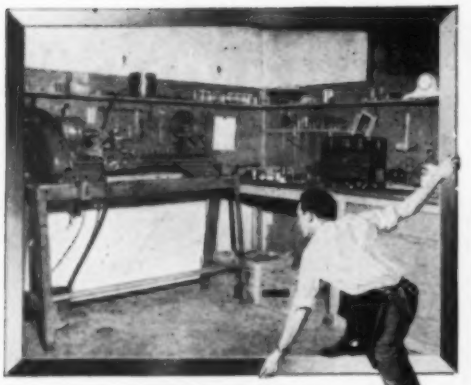
AA-62

the word for it is Performance!

● Everything you want in a modern outboard motor can be summed up in one word . . . *Performance.* And when you choose an Evinrude you know you are getting *proved performance* . . . the *certainty* of fine performance that means utmost enjoyment and satisfaction for the years ahead. *Starting ease* so sure and eager that it seems almost automatic. Superbly smooth power, with motors floated in vibration-absorbing bearings. Co-pilot steering. Large capacity fuel tank for wide cruising range. Trouble-free cooling that can never fail. *Long life*—many Evinrudes built more than 30 years ago are still delivering satisfying *performance!*

See your Evinrude dealer — look for his name under "Outboard Motors" in your classified telephone directory. Catalog of the complete Evinrude line sent on request — write for it today! EVINRUDE MOTORS, 5216 North 27th Street, Milwaukee 9, Wisconsin.

EVINRUDE
OUTBOARD MOTORS



GET INTO THIS HAPPY PICTURE

A well equipped home shop is the dream of many a man. It's the best hobby of all if you like to use tools. Most practical, too, when you consider the hundreds of useful articles you can make for your home — and the time and money you can save by repairing your own home appliances and equipment.

Atlas tools are ideal for such a shop — engineered for precision workmanship, and ruggedly constructed to give you a lifetime of service. They are built with modern production techniques to give you exceptional values.

Long-standing industrial reconversion orders will soon be filled. Keep in touch with your Atlas distributor. Send for this fully illustrated catalog to make your plans.

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ATLAS PRESS CO.
455 N. PITCHER ST.
KALAMAZOO 13D, MICH.

6"-10" Lathes

Milling Machines

Shapers

Drill Presses

War Device Becomes Play Ball

A PEACETIME play ball (above left) that weighs less than 10 ounces but is tough as an elephant's hide is being made with the same dies that produced the wartime, life-saving solar still (above right). The still had a black bag inside the Vinylite plastic sheeting and provided fresh water, without the use of chemicals, from salt water for men lost at sea.

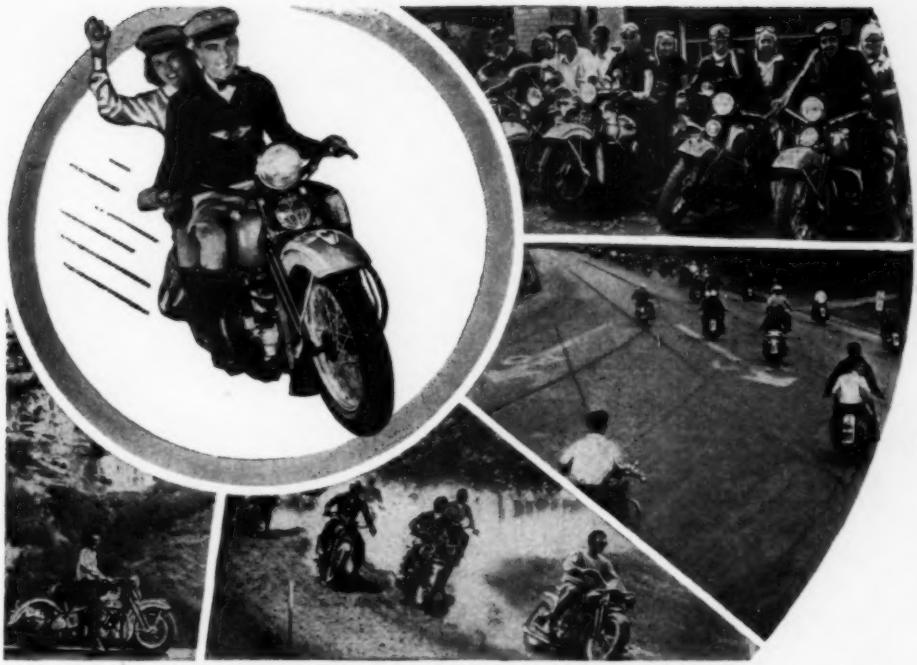
Twenty-two inches in diameter when inflated, the silvery "bubble" has seams that are electronically welded together and is strong enough to withstand the weight of a 250-pound man. In fact, a noted wrestler tested it by jumping on it.

Its lightness and toughness make it fine for play and exercise in the gymnasium or nursery or on the beach. Several plastic balls have already been added to the exercising equipment of a prominent model agency, where students use them to develop grace and posture.

Three New Wax Plants Found

THREE wax-producing plants not previously known were recently discovered 600 miles up the Amazon River in Brazil by Nelson S. Knaggs, of the Hilton-Davis Company Division of Sterling Drug Inc., Cincinnati. Now being analyzed to determine whether this wax can be adapted to commercial uses, the plants' products would alleviate the scarcity which has upped the price of wax from 35 cents to $1.50 a pound.

The new wax is needed, according to Knaggs, for use in lipstick, phonograph records, printing inks, shoe, auto, and furniture polishes, waterproofing, and many other applications. The carbon-paper industry alone uses an estimated 15,000,000 to 20,000,000 pounds a year.



FOR THRILL-PACKED EVENINGS · WEEKENDS · VACATIONS

Ride A HARLEY-DAVIDSON

PACK every spare hour brim full of pleasure—swing into the saddle of a Harley-Davidson and *go where there's fun!* Join other Harley-Davidson fans in the world's greatest sport — motorcycling. Ride along shimmering lakes and rivers — see majestic hills and forests — visit the country's many natural wonders and beauty spots. Go whenever you get the urge—stop wherever you choose — with no timetables to follow. What's more, there's always plenty of excitement and thrills when you ride a world famous Harley-Davidson on tours and endurance runs — or take in race meets, hillclimbs and other motorcycling events. See your Harley-Davidson dealer AT ONCE!

HARLEY-DAVIDSON *Motorcycles*

HARLEY-DAVIDSON MOTOR COMPANY, Dept. PS, Milwaukee 1, Wis.

Please send at once free copy of 24-page "Enthusiast" Magazine, filled with motorcycle action pictures and thrilling stories.

Name.....

Address.....

City.....*State*.....

SMOOTH Alternate Firing

A sweet running motor is half the fun of boating. That's why you surely want Johnson's Perfected Alternate Firing. It gives you that silken-smooth flow of power that makes Sea-Horse motoring something special!

DUAL CARBURETION

You've heard of the motor that packs real power—*smooth* power—at high speed, yet gives you velvet smoothness at a *crawl!* That's Johnson Dual Carburetion (one of the "big three" of outboard motoring) accounts for this beautiful performance.

REVERSE with 360° Steering

Of *course* you need reverse. Reverse is one of the "big three" of outboard motoring. Sea-Horses have it. Steer forward, sidewise, turn around or back up. That's maneuverability!

JOHNSON SEA-HORSES

FOR DEPENDABILITY

Free~

HANDY CHART

Sea-Horses are strictly quality motors—built with dozens of refinements. In addition to the "big three" described above, there is Patented Co-Pilot which "takes hold of the motor when you let go," Synchro-Control for one lever operation, Ready Pull Starter, Rubber Rotor Force Pump—and much, much more. » There is something else, too, which is mighty important. That is expert Johnson *service*—available wherever outboard motors are used. » See your Johnson dealer. Look for his name under Outboard Motors in your classified phone book. Or write for a copy of the Sea-Horse Handy Chart which gives specifications on the entire line.

JOHNSON MOTORS, 500 PERSHING ROAD, WAUKEGAN, ILLINOIS

JOHNSON BUILDS SEA-HORSE MOTORS ONLY—NO OTHERS

THERE IS NO SUBSTITUTE FOR EXPERIENCE

WOULDST CARVE WOOD?

You'll Find X-acto Knives "Indispensable" Says Famous Wood Sculptor

Visitors to the Open Air Art Show in New York's Washington Square last Fall were fascinated by the sight of a sculptor carving sophisticated modern figures with a small metal knife.

The sculptor was Nicholas Mocharniuk, whose work has won acclaim in galleries and art centers throughout the country. And the knife he was using was a No. 6 X-acto!

Mr. Mocharniuk uses X-acto Knives because he says, "they give the best results with the hard wood I use . . . they are especially suited to cutting away areas usually hard to get at."

You Can Take It With You

Another advantage Sculptor Mocharniuk points out about X-acto, is that he can take it with him and get in a bit of extra work while sitting on subways, trains or park benches.

Whether *you* work in hard or soft wood, in your workshop or out in the park, you too will find this removable-blade hobbycraft knife the handiest little tool you ever had.

CHOICE OF EXPERTS IN EVERY FIELD

With its 13 scientifically designed blade shapes, and 3 all-metal handle styles, X-acto is the perfect tool for the most difficult or delicate cutting job. Blades are of fine surgical steel, scalpel-sharp. Model builders, artists, whittlers, photographers, swear by easy-to-use X-acto.

X-acto*
KNIVES & TOOLS

X-acto Knives & Knife Chests From 50c to $5.00

Buy where you see this sign. At better hardware, hobby and gift shops — or if not available write direct to X-acto Crescent Products Co., Inc., 440 Fourth Avenue, New York 16, N. Y.

*Reg. U. S. Pat. Off.

You Have "The Last Word" with X-acto!

To keep our Knives and Tools the "last word" in hobbycraft, we're always making them *even better* than they are. Here are some new points about X-acto Knives and Tools and how to enjoy them:

NEW CHUCK COLLET—Grips blade even more firmly, tightens it with less pressure, gives it a longer reach.

NEW BLADES—2 new chisel blades for working those hard-to-reach flat surfaces. No. 17 is ¼" wide; No. 18 is ½".

NEW BOOKLETS—(1) "Building Your First Flying Models". (2) "Whittling Is Easy With X-acto". Each 32-pages, illustrated, 10¢ a copy.

NEW TOOL—Small size Spokeshave for fine shaving, rounding, shaping where block plane can't reach. Solid one-piece handle, all metal and surgical steel blade. 50¢.

NEW SET—No. 85 Tool Chest, containing 3 all-metal knives, with full assortment of blades; saw; sander; stripper; planer; 2 drill holders; 10 drills; 6" steel ruler. Complete in wooden chest, $12.50.

*So inconspicuous

YES . . . I'm on speaking terms with *all* my friends now that I wear a Zenith Hearing Aid, and can hear again.

I wasn't always so smart. I used to be as hard headed as I was hard of hearing. Thought it was *my* affair if I didn't want to wear an instrument.

But when even my best friends quit *trying* to make me hear, I discovered my defective hearing embarrassed them as much as it handicapped me. They hated to shout—and I hated to be shouted at.

That's when I got my Zenith. Wear it as casually as eyeglasses, too, because its Neutral-Color Earphone and Cord are hardly noticeable.

So I'm getting a big kick out of life once more. Smartest thing I ever did for myself *and* my friends was putting on a Zenith Hearing Aid!

* * *

Hard of hearing? See *your* Zenith dispenser this week for a free, private demonstration of the Zenith Radionic. You owe it to yourself, your family and friends. No one will press you to buy. And you adjust the Zenith to your own hearing needs with the flick of a finger. It's easy as focusing binoculars! For *free* descriptive literature, write: Zenith Radio Corporation, Dept. PS-4B, Chicago 39, Illinois.

Choice of Amplifier Colors at no Extra Cost.

Super-powered Model A-3-A $50
Model B-3-A (Bone Conduction) $50
Standard Model A-2-A $40

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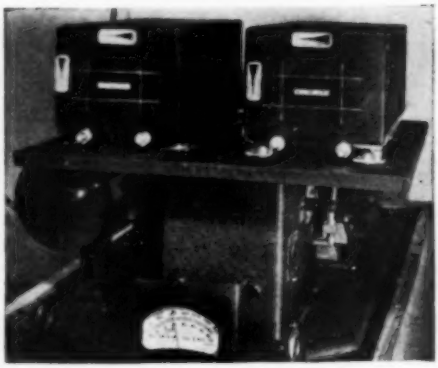
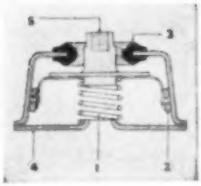


Comparison tests show vibration absorption. The block at left is on conventional mounts.



Points at which shock is absorbed in the new mount are indicated in the cutaway at right.

Mount for Instruments Absorbs Shock in All Directions

UTILIZING an entirely new principle, a shock-absorption mount for delicate instruments has been developed by Robinson Aviation, Inc., of Teterboro, N. J. It combines a damping system, a snubbing system, and electrical bonding in a single aluminum housing, and with them absorbs vibration in any direction.

The unit was originally designed for mounting such delicate equipment as airborne radar and photographic instruments. It is made in three sizes for loads of from ½ to 45 lb.

An actual test of the new mounts is shown in the photo above. Identical test blocks are mounted on the same vibrating stand, the one at left on conventional shear-type mounts and that at right on the new Vibrashock unit mounts. Horizontal and vertical indicators on the face of the conventionally mounted piece are blurred in the photo because of vibration, while they show plainly on the other block.

In the cutaway drawing the principal load-bearing spring is shown at Fig. 1, a damper to kill low-frequency oscillation and minimize resonance at critical frequencies at Fig. 2, and a snubber furnishing a resilient stop to limit heavy load shocks at Fig. 3. Figure 4 is the housing, and Fig. 5 a load-carrying stud tapped for standard machine screws.

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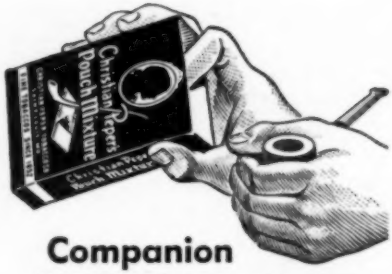

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Spot Welder Has Tweezer Leads

INSULATED, forged copper tweezers enable users of the new Besco spot-welding machine to weld metal parts smaller than an eighth of an inch around or thick. Previously it has been difficult to weld parts this small because they are so hard to hold. With tweezer leads, the electrodes can now be applied directly to the parts that are to be joined.

The new spot-welder, made by Tweezer-Weld Corp., of Newark, is a portable unit about the size of a small radio and weighs 25 pounds. It has a foot switch and plugs into a 115-V., 60-cycle power supply. The tweezers do not heat up, and the points need touching up only once a day.

N. Y.-Washington Link Ready For U. S. Television Network

THE first link of a national 6,000-mile network planned by the Bell System for the transmission of television pictures and sound is ready. It is the coaxial cable running between New York and Washington, and it is intended for regular intercity television service six nights a week as well as for telephone use.

Images can be sent very short distances over special telephone wires, but this method results in too great an electrical loss when it is tried for long distances. The coaxial cable is a low-loss method of transmitting for long distances the broad band of frequencies that make up television signals.

A coaxial cable, lead-covered, usually contains from six to eight conductors. Each conductor is a copper tube about the size of a lead pencil, with a heavy copper wire extending through its length and held in its center, out of contact with the tube, by plastic disks. Each tube, with associated equipment, can accommodate a television channel or 480 telephone channels.

HAWAIIAN WIGGLERS

Get Bass!

Shallow Running
No. 2 Hawaiian Wiggler — $1.10

Favorites at Fishing Camps For Large and Smallmouth Bass

Elmo Hurst with bass caught on No. 2 Hawaiian Wiggler

At left is photo of Elmo Hurst, who runs a fishing camp on the White River near Cotter, Arkansas. He reports that the deep running No. 1 Hawaiian Wiggler is a killer for smallmouth in the White River and its tributaries. This catch of largemouth was taken on the shallow running No. 2 Hawaiian Wiggler at nearby Norfolk Lake. He reports that weedless Hawaiians with their quivering hula skirts are favorites with the anglers at fishing camps along the White River.

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If you want some fascinating and informative reading, send for my free catalog that is loaded with photographs and letters from fishermen telling where and how record catches have been made with Hawaiians. It also gives the latest information on Jitterbug, my surface bait that is ideal for calm waters day or night.

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Old Surveying Device Used Again

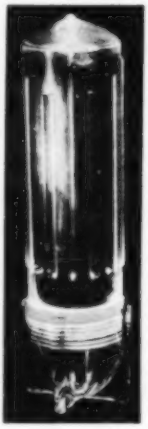
ONE hundred years old but still accurate, a 150-lb. surveying instrument was recently used to survey the grounds of Mission Santa Barbara when it was discovered in a subterranean vault. Ill-fated Emperor Maximilian of Mexico had presented the cumbersome device to the historic California mission.

New Lucite Flashlight, "Torch," Both Decorative and Useful

A NEW lucite flashlight, the Gemglo Torch, can be made to serve as a blinker signal light, night light, and table-light decoration.

When the cap of the Torch is turned, the flashlight beam is thrown on. Then it is merely a flashlight. It becomes a blinker signal light when a half-twist is given to the cap. Signals can be tapped out by pressing the base of the flashlight.

The cap is constructed so that the Torch can stand on end. Since the flashlight beam is diffused through the entire lucite barrel, producing a glow, the Torch is useful in the upright position as a night-table light in the bedroom or nursery. Several of the Torches, which are made in crystal or red lucite, can be placed erect and arranged as a dining-table decoration.



Manufactured by Gemloid Products Company, of Elmhurst, New York, the Torch is available in two shapes. One is provided with a metal handle enabling the light to be carried as a lantern or suspended from any height. The other is constructed in such a way that it may be stood on end as a steadily glowing torch.

Ford's out Front

WITH THE BIG 100 H.P. V-8 ENGINE

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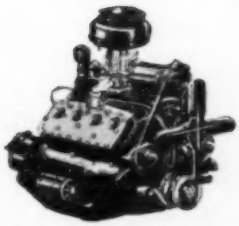
And Ford's out front with heavy-gauge steel bodies with long-lived, baked enamel finishes. See it at your Ford dealer's.



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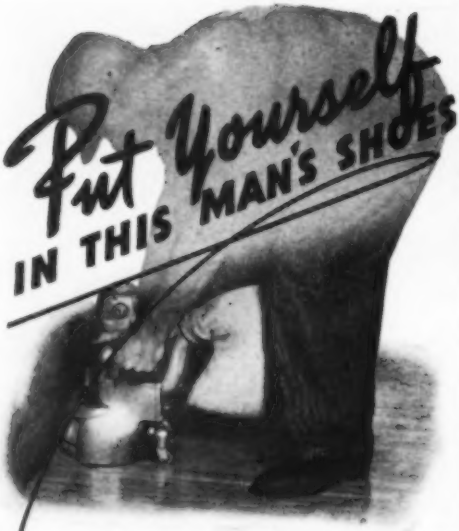

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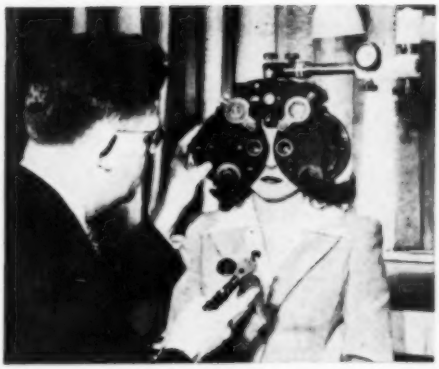


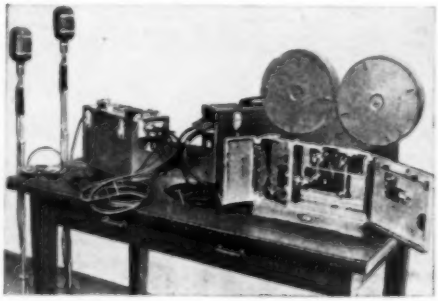
Uses Polarized Light to Test Eyes

A PORTABLE instrument that utilizes polarized light to check vision has been developed by the American Optical Co. for a program to promote efficiency and safety in factories. Polarized light was used because it vibrates in one plane only; ordinary light vibrates in all directions.

The instrument has eyepieces that contain Polaroid filters, and a target on a special film mounted between two sheets of glass. Test characters printed on the front side of the film are transmitted by light polarized in a vertical direction; those on the reverse side by light polarized in a horizontal direction. The eyepiece filters are so arranged that the subject's right eye sees only the front of the target while the left eye sees only the back. In this manner both eyes can be tested separately even while both of them remain open.

Simpler, Lighter Recording System

SIMPLER and lighter is Western Electric's new recording system. It contains a portable amplifier-noise reduction unit, power-supply unit, recorder, and two "mikes." It records standard original or release-type sound tracks on 35-mm. or 16-mm. film.



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RIGHT ANGLE PRISM—Flint Optical Glass, size 41 mm by 91 mm by 64 mm. Use in front of camera lens to take pictures to right or left while pointing camera straight ahead. Also used in front of camera lens to reverse image in direct positive work. Two of these Prisms will make an erecting system for a Telescope. **Stock # 3076-N** . . . . . **$3.00 Postpaid**

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624-N	Neutral Ray Filter, size 4¾" x 2½"	.25
22-N	Inclinometer—Aircraft type	.25 each
704-N	Lens Cleaning Tissue, one ream (480 sheets) size 7½" x 11"	1.50
1030-N	2" Diam. Reducing Lens	.25 each
2043-N	Crossline Reticle—Diam. 29 mm.	.50 each
1034-N	Burning Glass Lens	.25 each
535-N	Small First Surface Mirror	.30 each
3003-N	Amici Roof Prism with Corrected Roof . . .	2.50 each
633-N	Combination Polarizing and Infra-Red Filters, diam. 20 mm.	.50 each

(Minimum order on above—$1.00)

TANK PRISMS—PLAIN OR SILVERED

90-45-45 deg. 5¾" long, 2¼" wide, finely ground and polished. Perfect condition. Would normally retail from $24 to $30 each.
Stock # 3004-N Silvered Prism . . . . . **$2.00 Postpaid**
Stock # 3005-N Plain Prism . . . . . **$2.00 Postpaid**
Illustrated Book on Prisms included FREE

TANK PERISCOPE

Complete Set Mounted Components

Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Would normally retail at $40 to $50.
Stock # 700-N . . . . . **$2.00 Complete Set Postpaid.**

Order by Set or Stock No. • Satisfaction Guaranteed • Immediate Delivery

EDMUND SALVAGE COMPANY, P. O. AUDUBON, NEW JERSEY

GET READY FOR SPRING

1. CLEAN RUST OUT OF YOUR RADIATOR

with DU PONT Cooling System CLEANSER

Drain out your anti-freeze, and clean out winter's accumulation of scum, scale and rust. Neglect now may mean trouble and costly repairs later. Just pour a can of DU PONT COOLING SYSTEM CLEANSER into your radiator, run the engine 30 minutes or more, and drain.

2. MAKE IT RUST-PROOF
with DU PONT Acid and Rust INHIBITOR

After cleaning out the radiator, you can keep it free from rust all season by pouring in a can of DU PONT ACID AND RUST INHIBITOR. It prevents rust forming, and keeps out acid, too.

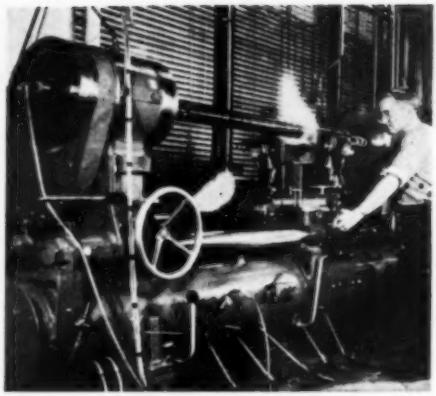
3. MAKE IT LEAK-PROOF
with DUPONT Cooling System SEALER

You can stop leaks quickly and securely—and make the cooling system LEAK-PROOF—by pouring in DU PONT COOLING SYSTEM SEALER. It will not clog the radiator.

MAKE YOUR CAR LOOK NEW
with DU PONT NO. 7 POLISH

Clean away dull traffic film—restore the original lustre and beauty of the finish. A little rubbing with No. 7 Polish will make a wonderful improvement in the car's appearance. It's quick, easy and safe.

DU PONT BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



Lathe Makes Giant X-Ray Tubes

SUPER-VOLTAGE X-ray tubes, including doughnut-shaped tubes for betatrons, are produced on the immense glass-working lathe above. Weighing 4,000 pounds, and probably the largest in the world, the machine was designed and constructed by the Vacuum Tube Engineering Department of General Electric X-Ray Corp., Chicago. There is less than .0005 inch variation in the relationship of the chuck spindles and the lathe bed across the entire nine-foot length between the chucks. The bed table itself is 13 feet long.

The machine can handle any piece of glass as long as 84 inches. Tubes, which pass through the spindles, are limited in length only by the size of the room. Thus, the lathe is excellently adapted to the production of long, multisection 1,000,000-volt and 2,000,000-volt X-ray tubes.

Birds Fooled Nazi Radar Units; Were Called "Spurious Echoes"

GERMAN radars picked up flights of birds, just as British and American sets did, but instead of analyzing them correctly the Nazis called them "Scheinziele," or "spurious echoes." British investigators found a German document on the subject, which noted that these "spurious echoes" came with special frequency from the wide mouths of rivers but said "their physical origin is so far unexplained. It is probably a matter of sharply bounded layers of discontinuity in the atmosphere. Charges, cloud movements, aerial vortices, as well as the boundary region between two layers of air, can be suggested as possibilities." They even planned a program of research to locate such "discontinuities" in the atmosphere.

Great Moments of THE WAR!

—by Graflex

Get your FREE copy now!

Here are great pictures of the war! Shot by combat cameramen on all our battle fronts! With this thrilling photo-record of the war is a story of photography's role in our victory! Send 10¢, to cover handling, to Room 34, GRAFLEX, Inc., Rochester 8, New York, or ask your local GRAFLEX Dealer for a FREE copy.

VISIT Graflex Information Centers—At 50 Rockefeller Plaza, New York, N. Y. and 3045 Wilshire Boulevard, Los Angeles, Calif.

GRAFLEX INC.

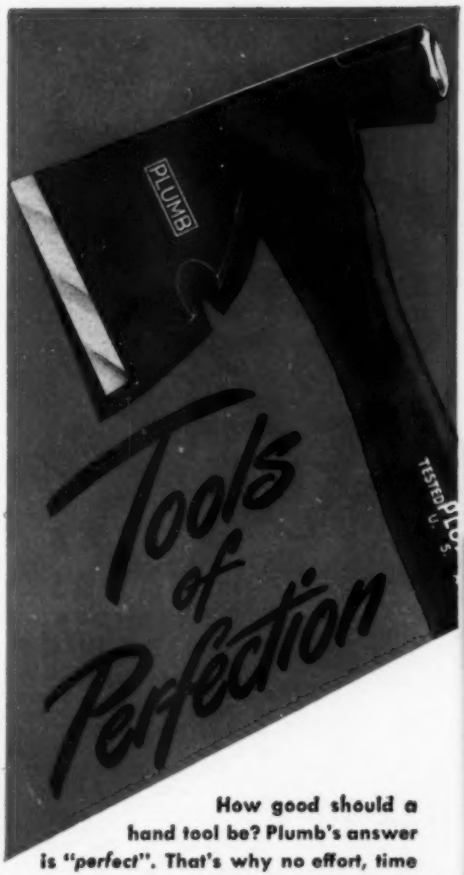
Do Your Own Welding and SAVE MONEY

With the MAGIC WAND electric flame and metallic arc Welder, beginners quickly become expert at welding, brazing and soldering. This complete, portable outfit, built into a handy, shock-proof carrying case, is ready for instant use anywhere, by plugging in on the nearest 110-V, 60-cycle AC outlet. Handles any metal—steel, iron, bronze, brass, aluminum, etc. Includes heavy-duty transformer with 6 stages of welding heat; dual-purpose electrode holders (flame and arc); polarized outlet plug; welding, brazing and soldering sticks and fluxes; welding helmet; Instruction Manual. Weighs less than 30 lbs. packed. Quickly pays for itself. Sold by hardware dealers and automotive jobbers.

COMPLETE $34.50 F.O.B. FACTORY

For Descriptive Folder, address:
JOHN H. GRAHAM & Co. INC.
General Sales Agent
Dept. E, 150 Duane St., New York 8, N. Y.

Magic Wand **WELDER**
MADE BY PATENT SPECIALTIES, INC., NEW YORK, N. Y.

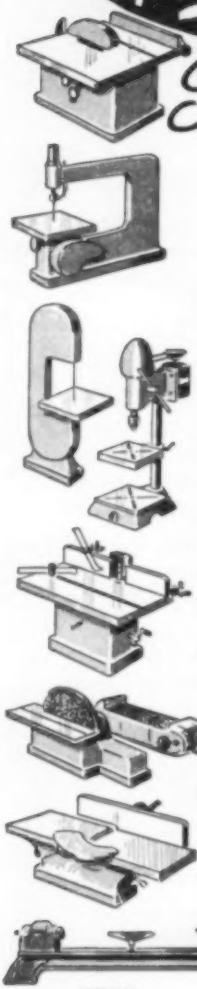


How good should a hand tool be? Plumb's answer is "*perfect*". That's why no effort, time or research has been spared to make the Plumb name mean "tools of perfection".

Plumb hand tools last longer . . . do the work better, faster . . . are correctly balanced for comfort and ease. Head of one-piece special analysis steel . . . handles of tested second growth hickory. Each tool is easily identified by the red handle and the black head. Fayette R. Plumb, Inc., Philadelphia 37, Pa.

PLUMB

POWER KING TOOLS ARE BACK!



Skillful

"EXTRA HANDS" FOR YOUR WORKSHOP

Soon your workshop can hum again to the tune of Power King Tools—skillful "extra hands" to save you time and increase the number of useful projects you can make in your leisure hours.

Several of the tools shown at the left are in production and will soon be on the way to dealers.

You'll be amazed at their many new construction features and smooth efficient operation, and the unusual values that bring a complete Power King equipped shop within reach of all.

FREE CATALOG SHEETS

Write today for descriptive literature to help you make your new power tool shop plans. Keep in touch with your Power King dealer to see the new tools when they arrive.

POWER KING TOOL Corp.
435 Cleveland St., Warsaw, Indiana

POWER KING
POWER KING TOOL CORP.
WARSAW, INDIANA

INTRODUCING-New Victory Model
HANDIWELD ELECTRIC
ARC WELDER

RETAILS ONLY $1.95
FULLY GUARANTEED

PLUGS into LIGHT SOCKET

VICTORY Model Handiweld Arc Welder operates from 110 volts, A.C. or D.C. current same as other arc welders higher priced; generates tremendous heat to weld all metals. Not a toy welder that uses carbons, but actually uses standard coated rods —sizes 1/16" and 3/32". Generous quantity of 1/16" and 3/32" rods supplied with the welder. Guaranteed not to burn out. Repairs fenders, auto bodies, radiators, machinery parts, etc. Take Victory Model Handiweld anywhere to job, operate right from light socket. You'll find a thousand uses for this welder around your home, garage, workshop. Also in garages, factories, repair shops, tin shops; mechanics, inventors, plumbers, farmers, etc. Order a "VICTORY MODEL" HANDIWELD today!

SEND NO MONEY We'll rush one to you with rods, helmet, operating instructions, and all necessary parts with the exception of a large jar and small piece of extension cord; these most everyone has. Pay postman only $1.95 plus few cents p'st'ge. If not delighted return Victory Model Handiweld in 5 days from receipt and money paid for it will be refunded promptly. Rush your order now.

KUMFY PRODUCTS, Dept. C-205, Cincinnati 25, Ohio

WRITE For FREE Literature

THE RITE-WAY MOWER ATTACHMENT

BUILD YOUR OWN POWER LAWN MOWER

WHY BREAK YOUR BACK MOWING FIELD OR LAWN?

Now anyone can save time and effort mowing field or lawn, by building their own whirl type power mower.

We furnish complete information, and whirl type blade attachment. Write today.

T & H Mfg. Co.
811 E. 31, Dept. D.S-1, Kans. City 3, Mo.

TENNIS
SAVE on our LOW PRICES

● Gut Tennis and Badminton Strings direct from factory to you. ● Vises & Frames ● Tennis Equipment.

H. E. WILLS CO. Catalog FREE
1047 W. 47 St.
Dept. PS-46
Chicago

MAKE MONEY AT HOME

RUBBER MOLDS
Low as 6¢ EA.

Amazing rubber mold-making outfit makes perfect flexible molds of plaques, ash trays, bookends, etc. Molds cost 6c to 25c each. Each mold makes hundreds of novelties and gifts to sell for $1.00 apiece and more! No experience necessary. Everything furnished. Quick and easy. Start profitable business in your home—sell to stores, gift shops, friends, resorts, road stands, by mail. Full or spare time. Write for complete FREE details and easy instructions.

SO-LO WORKS, INC., Dept. E-801, Loveland, Ohio

$1 RIDS YOUR LAWN OF UGLY WEEDS!

WEED-NO-MORE

Magic Weed Killer

Destroys Ugly Weeds but Won't Harm Common Lawn Grasses!

NO MORE back-breaking digging! Destroy ugly leafy weeds with WEED-NO-MORE!

The 8-ounce lawn-size package treats 1600 square feet! Now *you* can enjoy a beautiful weed-free lawn for *only* $1!

WEED-NO-MORE kills dandelion, plantain and other ugly weeds—yet won't injure soil.

Get it today! Rid your lawn of ugly weeds for only $1. Just spray on . . . WEED-NO-MORE!

On Sale at Paint, Hardware, Garden Supply, Department and Drug Stores

WEED-NO-MORE

THE AMAZING NEW WEED KILLER

Made by THE SHERWIN-WILLIAMS Co. Cleveland, Ohio

HULL Automobile Compass

You're on the right course always with a **HULL AUTOMOBILE COMPASS.** No lost directions, backtracking, delays. Reliable for years, out of the war with improved accuracy. Ask your dealer for a HULL—the leader. Circular free. **Price $3.50.**

HULL MFG. CO.

P. O. Box 246-E5 **Warren, Ohio**

BUILD ARC WELDER FROM SCRAP

We Show You How to build this new powerful welder without rewinding. For light or heavy work. Uses coils taken from old auto generators. Works on 110 or 220 volts A. C. Has 20 different heats. Send 35c for complete PLANS and valuable Catalog. Write today.

LEJAY MFG. CO., 1323 Lejay Bldg., Minneapolis 8, Minn.

SHAW "DU-ALL" and "Peppy-Pal" GARDEN TRACTORS

● 1 to 9 H.P. Circulars on request. Building more now—We supply repairs for all SHAW Tractors sold in our 42 years in business.

BUILD YOUR OWN RIDING TRACTOR—"WAR HORSE"

using old auto parts, powered by 2 H.P. or larger air-cooled engine; or walking type Garden Tractor ½ to 3 H.P. or convert truck or auto into Farm Tractor. Each with steel or rubber tires: will plow, cultivate. Plans for building, in few hours, any one of above, postpaid for $1.00 (state which wanted) or all 3 for $2.00. Money Back Guarantee!

SHAW MFG. CO., 3704 FRONT ST.
Galesburg, Kansas
668PS North 4th St., Columbus, Ohio

DUST INVITES GERMS

Ordinary dust raised in sweeping carries myriads of germs which can remain virulent for weeks and even months. That is one reason why thousands of factories, shops, stores, and schools are adopting "Dustless" sweeping. Daily sweeping with a Dustless brush and Arbitrin sweeping fluid reduces bacteria in the air as much as 97%. You ought to know all about this better method of sweeping. Write for complete facts today.

MD

- Dustless
- Speed Sweep
- Speed Wash brushes

MILWAUKEE DUSTLESS BRUSH COMPANY

528 N. 22nd Street • Milwaukee 3, Wisconsin

THE MAKING OF
Marlin GUNS

Marlin brings to sportsmen, through this series of advertisements, interesting facts on gun-making—to enhance appreciation of fine sporting firearms and to encourage their thoughtful handling and care.

RIFLE'S HEART • Inventive genius and fine craftsmanship mark firearms actions which have stood the test of time. The action is the main "works" of the rifle. Mechanism which carries cartridge from magazine to chamber...locks action... strikes firing-pin...pulls out and ejects cartridge ...is so compact that it fits into a man's hand. All working parts are heat-treated for lifetime wear. Assembling is entrusted only to craftsmen of great experience and skill. All actions are tested before shipment.

Assembling action of the Marlin 39-A Rifle.

Testing actions at Marlin Firearms Plant.

SOLID TOP RECEIVER • A major advance in firearms design and the invention of J. M. Marlin. Solid top permits lowest possible mounting of telescope sight. Cartridge cases are ejected *at side, cannot* fly in shooter's face.

AT RIGHT are shown the "insides" of the Marlin 39-A Rifle. Its famous action has been continuously improved over half a century. Note solid top receiver, simplicity of mechanism.

ALL WORKING PARTS of Marlin's 39-A are exposed for cleaning and oiling by turning a single take-down screw. This Marlin is the only lever-action, .22 cal. repeating rifle made.

(The next advertisement in this Marlin series will reveal more interesting facts on fine gun-making.)

THE **Marlin** FIREARMS CO.
NEW HAVEN, CONNECTICUT, U. S. A.

BE SURE TO SEE MARLIN 1946 MODELS ON DISPLAY AT YOUR DEALER'S

Makes Straps of Scrap Nylon

BECAUSE three watch straps rotted on his wrist in Sicily, Henry J. Rand decided, after discharge, to manufacture straps impervious to water, perspiration, and stain. He succeeded, using scrap nylon fiber.

Offer $2,000 for Best Essays About Resistance Welding

CASH prizes totaling $2,000 will be awarded next fall by the Resistance Welder Manufacturers' Association for the best papers on resistance welding. Essays may be devoted to redesign of a product for resistance welding, to resistance-welding research, or to the development of new methods, and must discuss work and ideas that are clearly original. The economic importance of such accomplishments should also be explained. Papers must contain at least 2,500 words and three typewritten copies, double-spaced, should be furnished.

Prizes of $750, $500, and $250 will be given for the best papers submitted by contestants employed in industry, engineering, or a government or private laboratory. An award of $300 and another of $200 will be given to university faculty members or students whose papers contribute the most towards furthering the advancement of resistance welding.

The contest closes on July 31, 1946. Winners will be chosen by judges appointed by the American Welding Society, 33 West 39th Street, New York 18, N.Y., to which all manuscripts should be sent.

THE ONE AND ONLY PIPE OF ITS KIND

VanRoy

with the NEW

Ajustomatic

STEM

VanRoy Ajustomatic Bard $5

At last a new kind of screw-stem pipe with a stem that stays on the beam. With VanRoy Ajustomatic the patented, "float-mounted" stem will not lock at an off-angle. No matter how often it is turned the stem holds its precision alignment for the life of the pipe. For the utmost in smoking satisfaction—get Ajustomatic, a pipe in the tradition of VanRoy quality.

Signal of Quality in Pipes

VANROY COMPANY, Inc., Empire State Bldg., N. Y. 1, N. Y.

Now Hear Better

THE AMAZING NEW

Beltone WAY

COMPLETE IN ONE POCKET-SIZE UNIT (with cord and plug)

Beltone Mono-Pac brings you a new world of sound—amazingly clear, natural—perfected by advanced electronic research. One lightweight unit—about the size of a spectacle case—does it all. Weighs about one-half as much as old style hearing aids with no clumsy, separate battery pack, no battery wire. Such a sensational advance that already tens of thousands of hard-of-hearing people have been delighted with how splendidly they hear now with this tiny but powerful device.

American Medical Association Accepted Council on Physical Medicine

Send Post Card Today for

FREE BOOKLET

with valuable information for hearing problems.

BELTONE HEARING AID CO., Dept. PS-4

1450 W. 19th Street, Chicago 8, Illinois

SWIVEL-HEAD FLASHLIGHT

nothing else like it!

HEAD TURNS LIGHT AT ANY ANGLE

Greatest advance in flashlight design in a generation. *Turn powerful pre-focused beam where you want it . . .* stand it up . . . clip it on . . . both hands are free. A handsome, durable, all-purpose flashlight for everyone. Ask your dealer.

$2 LESS BATTERIES

No. SW-22 Patented

No. 73 Heavy-Duty Dated Cell. Fresh — Lasts longer. 10¢

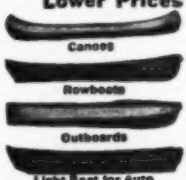
USALITE

Flashlights & Batteries

If dealer cannot supply, send $2.00 to Dept. O
UNITED STATES ELECTRIC MFG. CORP., New York 11, N. Y.
*USALITE *Red-Head* Safety Flashlight— a "MUST" for the motorist.

Thompson BEATS the World on BOATS

Better Built Lower Prices



Safe Boats With Full Length Spray Rails

Keep passengers perfectly dry—even at high speeds. Catalog also shows two new models of "Take-Along" Boats. Two big factories—save you freight.

CATALOG FREE

Write for your copy. State kind of boat in which you are interested.

THOMPSON BROS. BOAT MFG. CO. (181)

219 Ann St. PESHTIGO, WIS. (*Write to either place*) 119 Elm St. CORTLAND, N.Y.

SWISS MADE WATCHES

WEAR AT OUR RISK!

Swiss made watches are renowned for accurate time-keeping. The men's watch has a sturdy, finely constructed chrome case and an open figure dial, genuine leather strap. The ladies' watch is sure to evoke enthusiasm because of its exquisite daintiness. SEND NO MONEY. Just pay postman for men's wrist watch $8.50 and for ladies' wrist watch $15.00 plus few cents postage and 10% Federal excise tax. Wear for 10 days on our money back if not satisfied guarantee.

UNITED PRODUCTS CO.

7941 S. Halsted St., Dept. MMLR-181, Chicago 20, Ill.

NEW OTTAWA Wood Saw

FOR TRACTORS Makes wood sawing fast; easy. Cuts enough wood to pay for itself quickly. Easily moved while attached. Big blade; send for FREE details.

OTTAWA MFG. CO., W-401 Oak Ave., Ottawa, Kans.

When Writing Advertisers Please Mention Popular Science

New Designs in

FRANZITE GRIPS

Modernize Your Gun! Improve Your Score!

Most durable grips made. Positively unbreakable! For Colt, Smith & Wesson, Hi-Standard, Ortgies, Luger & Mausers in a wide choice of beautiful designs in ivory, pearl, walnut, onyx, etc. Low prices. FREE CATALOG. Dealers Wanted.

SPORTS, INC., (Mfrs.) 5501 Broadway, Dept. S-4, Chicago 40, Ill.

6 handy tools in ONE!

1 MITERING GUIDE
2 DIAMETER GAGE
3 ACCURATE SQUARE
4 MARKING GAGE
5 CENTER FINDER
6 CONVENIENT RULER

Miter Master takes the place of an expensive miter box accurately set to any angle. Scale marked for mitering 5, 6, and 8-sided frames. Steel construction. Built to last a lifetime. If your dealer can't supply you we will send it postpaid anywhere in the U. S. for $1.50. (Foreign $1.75). Unconditional guarantee. If not satisfied within ten days for any reason whatsoever, your money will be refunded.

MASTER SPECIALTY COMPANY

3024 EAST LAKE STREET • MINNEAPOLIS 6, MINN.

VISE-GRIP WRENCH

Vise-Grip does more things, easier and quicker, than any other tool! Remains locked to the work with hands removed. Holds anything, any shape, with a grip that never slips. Built with strength to back up its tremendous power. Is actually Hand-Vise, Clamp, Super-Plier, Adjustable End-Wrench, Pipe-Wrench, Locking Wrench and Toggle-Press — ALL IN ONE! Light, trim, handsome. Made of fine alloy steel. Electro plated. 7" and 10" sizes.

Sold by Tool Jobbers and Dealers.

PETERSEN MFG. CO., Dept. S-46, DeWitt, Nebr.

HUNTER'S COMPASS

Hunting Case, Watch Type, All Metal, Jeweled $3.50

Engineers All Metal Army Type Hand-Sighting LEVELS

$1.50

PUBLIC SPORT SHOPS

13 S. 16th St., Phila. 2, Pa. — No COD's

Pat. Pend.

LOCATES TROUBLE INSTANTLY IN ALL ELECTRICAL DEVICES

HANLAN APPLIANCE TESTER

In this single unit are combined all the necessary tests for examining every appliance. Checks thermostats under actual working conditions. Tells instant it opens or closes. Controls the heat on soldering irons. Prevents over-heating. Tests continuity, open circuits, etc. Checks automatic irons, vacuum cleaners, motors, shavers, bulbs, appliances with 3-way switches, etc. Great time effort and money saver! ONLY **$9.50** COMPLETE.

FREE with each Tester. New, Complete Practical Course in electrical appliance repairing. WRITE FOR CIRCULAR.

HANLAN CO., 1419-B, West Jefferson, Los Angeles 7, Calif.

---

120 MILES PER GALLON

Complete motor ready to mount on ordinary balloon-tired bicycle. No mechanical skill required to install. No alteration of bike necessary. Easy to operate.

Can be pedalled by merely releasing clutch. Speed 5 to 40 M.P.H. Shipped prepaid complete with 4 cycle, 2½ H.P. motor, all attachments and heavy duty stand. Get complete facts about this low-cost, convenient transportation. . .

Write today for descriptive illustrated literature.

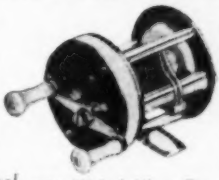
WHIZZER MOTOR SALES CO.

Dept. B, 3132 E. Washington, Los Angeles 23, California

Coming YOUR Way!

Here are the South Bend reels that are *now* in production; some may be on their way to your dealer. We suggest you keep in touch with him for early delivery of the reel of your choice.

THE PERFECTORENO — For Bait Casters



Now, Fishin's Fun — For Every One! Any one can cast, without backlashing, with a Perfectoreno. Needs no thumbing — makes casting easy, effortless, a real pleasure. Two models are now in production:

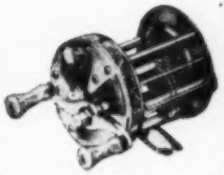
No. 775, Nickel Silver Frame; Mottled Pearl Grips.
No. 760, Maroon Anodized Aluminum and Smoky Pearl.

THE OREN-O-MATIC — For Fly Rod Anglers

Most popular automatic fly rod reel ever made. Hangs vertically from the rod, in natural, balanced position. Extra long, extra strong spring; anodized aluminum frame. Two of the most popular models of Oren-O-Matic reels are being made first:

No. 1130, Rich Maroon, Capacity 50 yards. "G" Line.
No. 1140, Rich Maroon, Capacity 80 yards. "G" Line.

ANTI-BACK-LASH REELS — The Original and Genuine

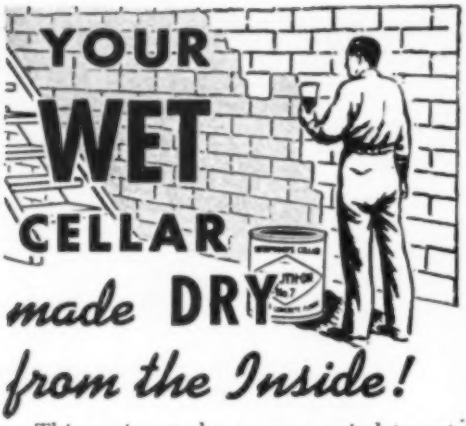


These are the original Anti-Back-Lash Level-Winding bait casting reels, the reels that first did away with discouraging snarls and tangles of line. So well are they made that some have been used more than 30 years, many handed down from father to son. Two popular models are now in production — No. 1000 and No. 450. No. 1000 is illustrated.

SOUTH BEND BAIT COMPANY
892 S. High St., South Bend 23, Ind.

SOUTH BEND

A Name Famous in Fishing



This spring make up your mind to get rid of the drippings, dampness, and mustiness that come from cracked or porous cellar walls and floors—for good. Waterproof them with Smooth-On No. 7 Iron Cement. Do it yourself—save delay and expense. Apply Smooth-On like paint—goes on wet walls or dry, on stone, brick, concrete. Hardens in 24 hours, expands to fill cracks and crevices, forming a tight metallic seal.

Equally effective for waterproofing cisterns, troughs, tanks, fountains, swimming pools, stables, garages, outbuildings and for smoothing up concrete floors.

Comes in 1-, 5-, 25- and 100-lb. sizes. 25-lbs. covers 100 sq. ft. Ask for Smooth-On No. 7 at your neighborhood hardware store. If they haven't it, write us direct.

FREE REPAIR HANDBOOK

Besides full directions for waterproofing your cellar, this free, 40-page, pocket size manual will give you information and instructions for stopping leaks, sealing cracks and tightening loose parts in heating and plumbing systems and other home equipment. 170 diagrams. Just send coupon.

Smooth-On Manufacturing Co., Dept. 58
570 Communipaw Ave. Jersey City 4, N. J.
Please send the FREE Smooth-On Repair Handbook.

Name.....

Address.....

4-46.....

Do it with **SMOOTH-ON**

Neither Ice Nor Boiling Water Fazes New Current-Converter

A RECTIFIER that turns alternating current into direct current as efficiently when it is immersed in boiling water or packed in ice as it does under normal conditions has been produced by the Westinghouse Electric Corp. Even salt spray, which used to destroy unprotected rectifiers on the decks of ships in a few hours, did not appear to faze the new type in tests. The latest current-converter is the result of seven years of secret research and development. It consists of a heavily tin-plated metal container in which a mineral element, selenium, is suspended in oil. The whole unit is hermetically sealed.

Twin rectifiers are shown above; the one at the left suspended in boiling water, the other in ice.

Geologist Claims Meteorite Did Not Dig Arizona Crater

MORE than $1,500,000 has been spent trying to find the supposed meteorite that made the famous Arizona hole that is usually referred to as Meteor Crater. Now comes Dr. N. H. Darton, of the U. S. Geological Survey, to say that the crater wasn't caused by a meteorite at all. He believes that it was produced by a volcanic steam explosion, and calls attention to the facts that (a) it is in a volcanic region, and (b) that a smaller but similar crater, Zuñi Salt Lake, 120 miles to the east, has a cinder cone in its center.

ELECTRIC DREMEL POWER TOOLS

MOTO-TOOL ★ THE "POCKET-SIZE" MACHINE SHOP

PUT THIS "WAR VETERAN" TO WORK

Approximately 27,000 R.P.M.

MODEL 2 Illustrated

READ MOTO-TOOL'S RECORD

Long before Pearl Harbor Dremel Moto-Tools had won their spurs in tool rooms, machine shops, home workshops. Now they have the respect of every branch of the armed forces. And thousands of them helped establish production records at General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Douglas and others.

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Kit No. 2 with 23 high grade accessories and Model 2 Moto-Tool, in hardwood case $23.50
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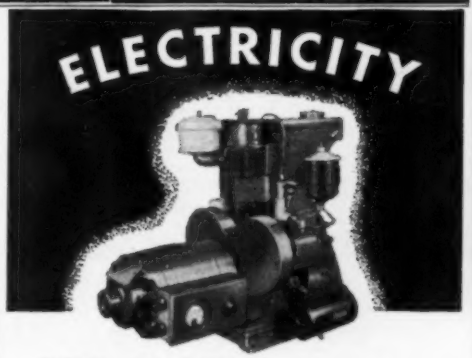

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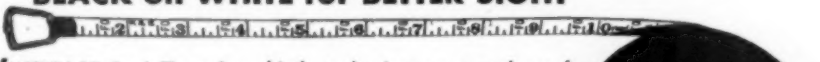

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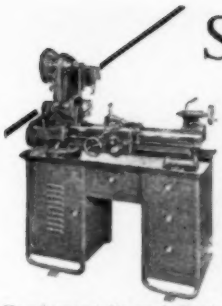

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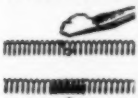

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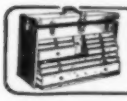

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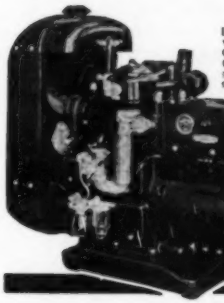

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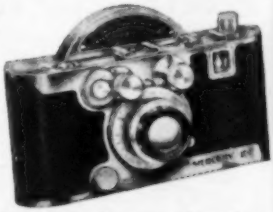

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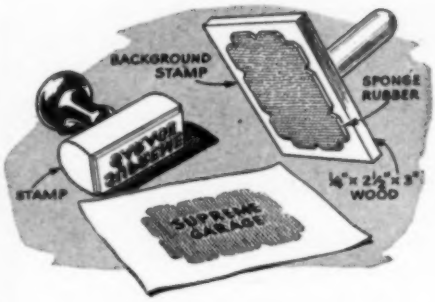
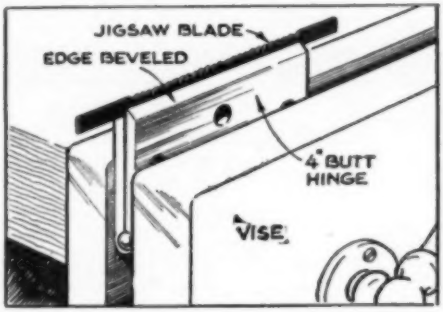


Background Stamp Cut from Rubber

SPONGE rubber and an ordinary rubber stamp provide a means of producing your own letterheads. Cut the sponge rubber to any design that strikes your fancy and attach it with rubber cement to a stamp made from flat wood and a short piece of broom handle, as indicated above. An attractive effect may be obtained by stamping the background in colored ink and the name in black.—W. A. JACOBSON.



Jigsaw-Blade Vise from Butt Hinge

JIGSAW blades may be sharpened in a vise made from a 4" butt hinge. Bevel the edges of the hinge as indicated in the drawing above. Any small bench vise gives the necessary pressure to the hinge.—H. C.

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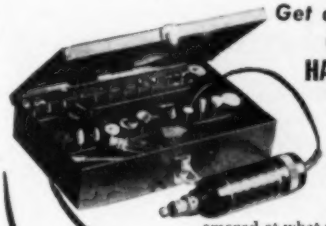

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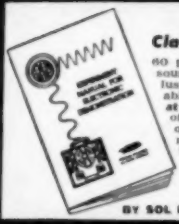

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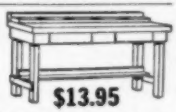

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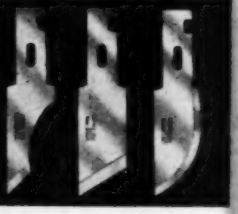

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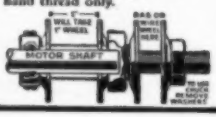

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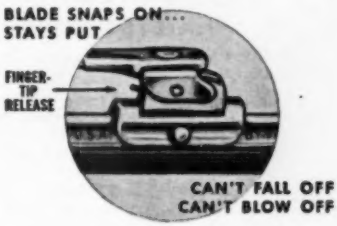

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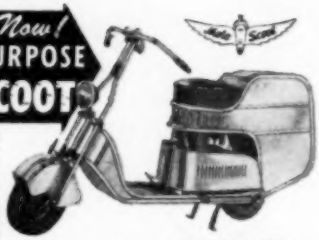

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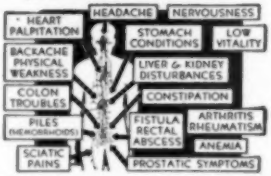

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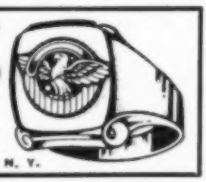

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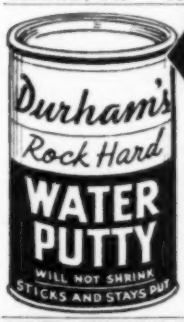

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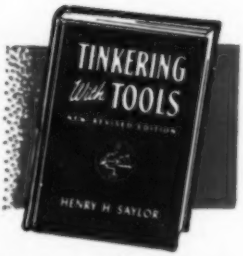

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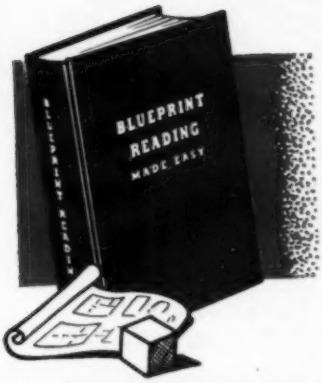

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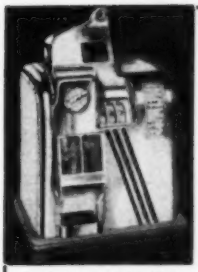

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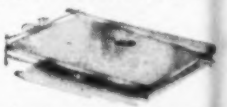

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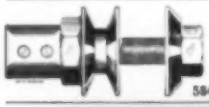

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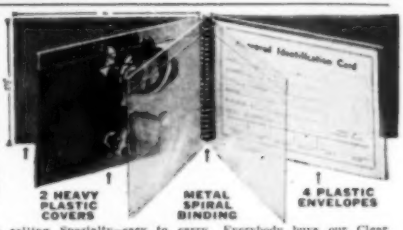

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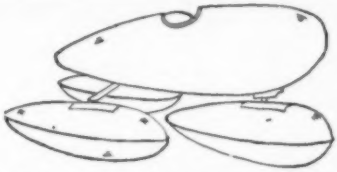

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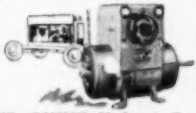

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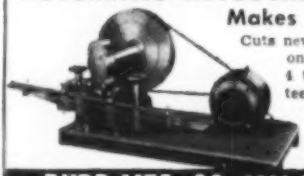

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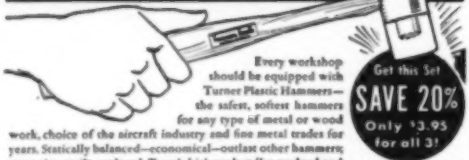

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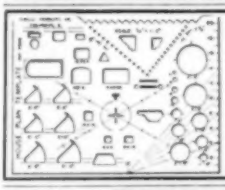

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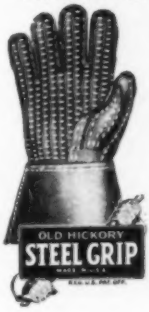

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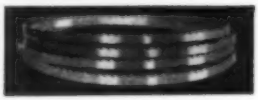

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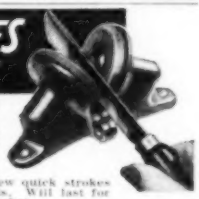

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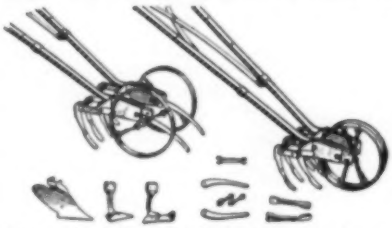

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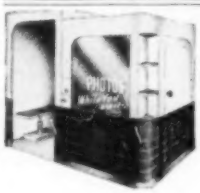

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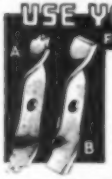

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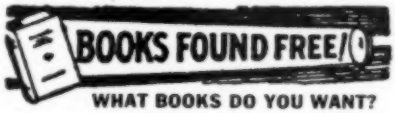

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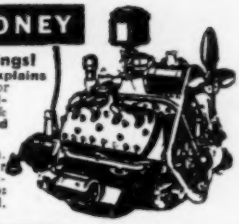

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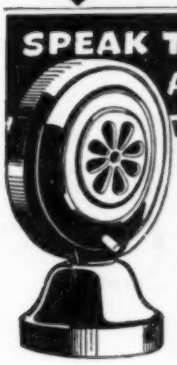

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THE McNESS COMPANY
232 Adams St. Freeport, Ill.

TO: Readers
FROM: Editors

The Story of A Story

IT BEGINS last January. The managing editors, the art editor, and myself sat around the long table in groping silence. Our job was to define the cover story that would be most in your interest for this, the April issue.

Outside, it was snowing. But inside, spring was warm on our necks. Spring meant the open shirt and the open road . . . that was it . . . the waiting roads of the first peacetime spring in years . . . and the deadly old cars, the dangerous human impulses bursting from the shackles of rationing. Here

Devon Francis comes from Indiana by way of the University of Kansas and newspaper work far and near. As aviation editor of the Associated Press, he flew around three continents and won the first TWA award for aviation reporting. He worked for *Time* and an air line before joining PSM. Although a licensed pilot and a spark plug of the Aviation Writers Association, he resents being typed and has written leading PSM articles on a wide variety of subjects.

was our story, *your* story—vital to you and your family and your friends. You can read "How to Drive and Stay Alive" and judge its usefulness for yourself. But you might like to know how such a story is handled.

Associate Editor Devon Francis caught a plane to Washington. He talked to the people at the American Automobile Association who had made a study of the problem. He interviewed others at the National Safety Council, the Bureau of Roads, the F.B.I., who knew causes and answers. A big insurance company provided more facts and shocking figures. We wired correspondents in other cities to ask outstanding professional drivers their rules for safe driving.

Hartley Howe took on the human angle. He talked with doctors, psychologists, court and Army officers. Through *Taxi Weekly* and Parmelee, he located New York's safest cab drivers. Harry Walton and Frank Rowsome set about inventing simple and practical gadgets to test driving skill. A modelmaker was called in to make the devices. Then Bill Morris and Hubert Luckett wheeled out the editorial Buick to test the

Frank Rowsome, Jr., learned editing on four other magazines before coming to PSM. A born gadgeteer, not even graduation from Harvard dulled his affection for tools. A true workbench as well as desk editor, he once tested a commercial welder, found it wanting, and forthwith built a better one. He lives in the country in a houseful of laboriously evolved labor-saving thingumajigs, and drives an 18-year-old flivver that automatically makes him a cautious motorist.

testers—and to photograph them in use.

Meanwhile, Lester Fagans was studying hundreds of pictures of crashes, from a dozen sources, to synthesize a crack-up for his cover painting. The whole art department worked overtime to sketch danger spots. Outside artists were called in to help dramatize the problem for you, and to show pictorially what you could do about it.

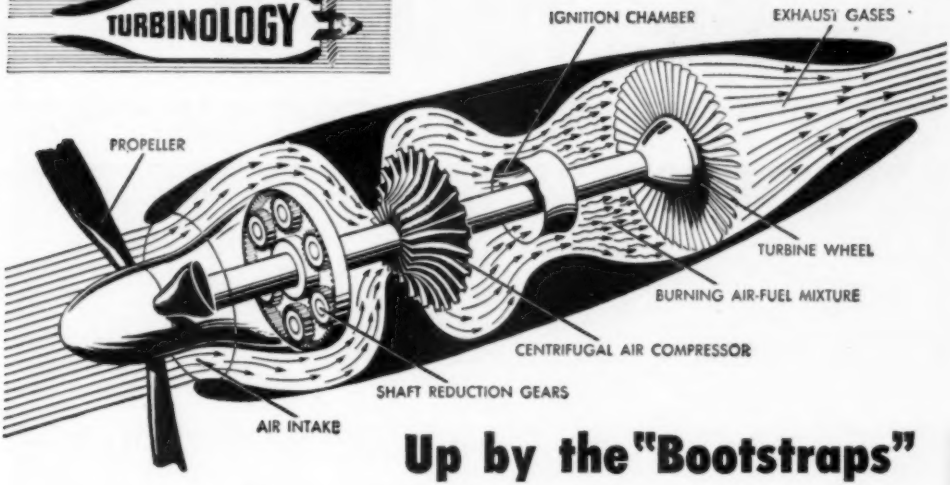
All in all, the story became a book, then the book was boiled down to a story. It is strong stuff, but remember while you are

Hartley Howe had two and a half stripes on the sleeve when he took off his Navy uniform to join PSM. He served in London, in a task force that installed the Mulberry artificial harbor for Normandy, and at Washington, in the Office of Public Information. Son of Louis McHenry Howe, he grew up in Washington, entered Harvard intending to be a physicist. He has worked for the United Press and *Life*. He authored "Stopgap Housing" last month with feeling: he is househunting himself.

reading it that somebody is dying needlessly in an automobile accident every time you turn a page. Don't let that somebody be anybody you know.

PG

TURBINOLOGY



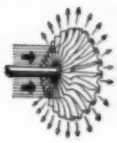
Up by the "Bootstraps"

At first glance, the new Wright Aeronautical propeller turbine for fast, long-range air giants resembles a man lifting himself by his boot straps. For the two main working units in this power plant are a compresser which supplies energy to a turbine wheel, while the turbine wheel in turn drives the compresser.

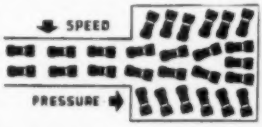
There's an "X" added, however. The "X" is the heat energy of gasoline or other fuel. Burned with compressed air, it creates a tornado of expanding gases—hot gases powerful enough to spin turbine blades, drive a propeller, turn the air compresser and still have unused force left over to jet out the exhaust for extra thrust.

The diagram above shows a schematic drawing of a Wright turbine. From left to right, here's what happens:

Air enters through an intake around the propeller hub. It is snatched up by the blades of an "impeller", the main part of a "centrifugal" air compresser. The air is hurled off the blade tips at high velocity, but without much pressure. Curving passages leading to the combustion chamber slow it down, build up pressure.



Imagine a double-lane express highway, with cars spaced well apart doing 80 miles per hour. That's velocity. If the express highway ends abruptly in a parking lot, the cars pack up bumper to bumper. That's velocity changed to pressure and is exactly what happens to air moving through the compresser of a Wright turbine.



In the combustion chamber, part of the air is burned with gasoline, producing a flame double the temperature of molten aluminum. This raging heat expands the rest of the air. Being compressed, it has further to expand. It's like adding a pinch of dynamite to a steel spring as it is released from full pressure. Just as air caged inside an inner tube blasts through any available opening, so this inferno of hot gases fights to get out into the open. The only way out is through the openings between the turbine blades. On its curved surface, each blade takes the full impact of this gaseous force.

The only way it can "roll with the punch" is to turn. And turn it does, with all the other blades on the turbine wheel and shaft. Enough power is put into the shaft to drive the geared propeller and the compresser both. Major part of the power goes to the propeller. The compresser takes only a small part of the total.

That, basically, is the way a Wright turbine works. Some models have different types of air compressers. Models will vary from 5,000 to up towards 10,000 HP. But all will work on the same principle of compresser-combustion chamber-turbine wheel. And all will mean new advances in both military and commercial aviation.

This is one of a series of explanatory ads on the propeller turbine of the Wright Aeronautical Corporation.

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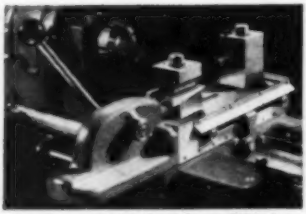
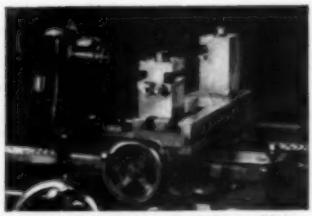
FROM SOUTH BEND LATHES WITH THESE ATTACHMENTS

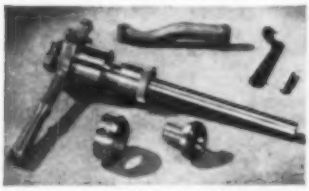
Handlever Bed Turret for 9" or 10" lathes multiplies their versatility through multiple tooling for repetitive operations.



Handlever Double Tool Cross Slide for 9" or 10" lathes speeds up successive operations through the use of three cutting tools.



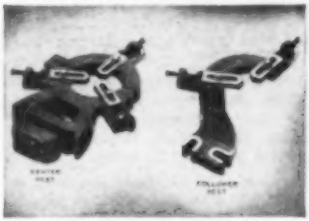
Screw Feed Double Tool Cross Slide for 16" lathes has both manual and power cross feed. Large graduated feed dial.



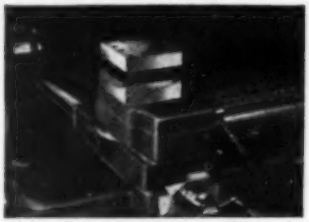
Handlever Draw-in Collet Attachment saves time on bar work. Collet can be operated and stock fed without stopping spindle.

Handwheel Draw-in Collet Attachment is ideal for production and toolroom work that requires extremely close tolerances.

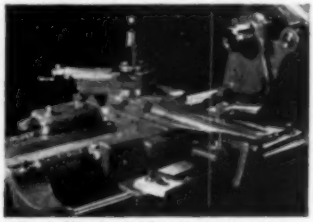
Collets from 1/16" to 1" in 1/64" steps. Complete sets of collets will save time.



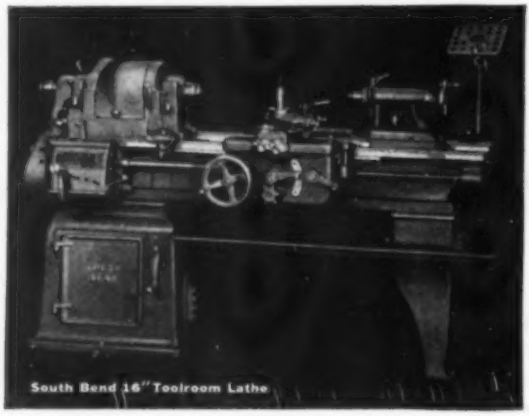
Center Rest and **Follower Rest** for supporting long bar work while turning, threading, drilling, boring, etc.



4-Way Turret Tool Block permits use of four cutting tools which simplifies tooling for repetitive operations.



Taper Attachment for accurate taper turning and boring. Quickly engaged. Graduated in both degrees and taper per foot.



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These and other practical attachments greatly increase the capacity of South Bend Lathes for a wide variety of operations. They simplify difficult set-ups, save time and effort, and often eliminate delay and expense of making special fixtures.

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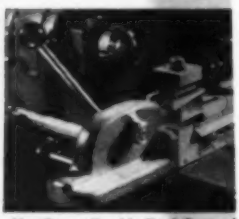
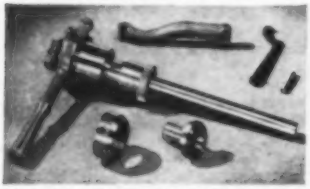
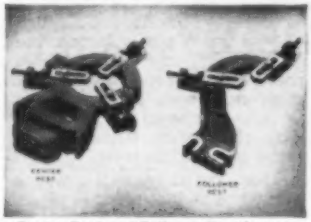


Handlever Double Tool Cross S 9" or 10" lathes speeds up successiv tions through the use of three cutti

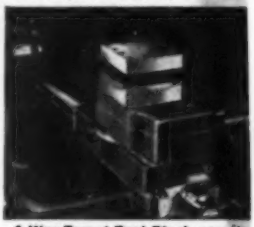


Handlever Draw-in Collet Attachment saves time on bar work. Collet can be operated and stock fed without stopping spindle.

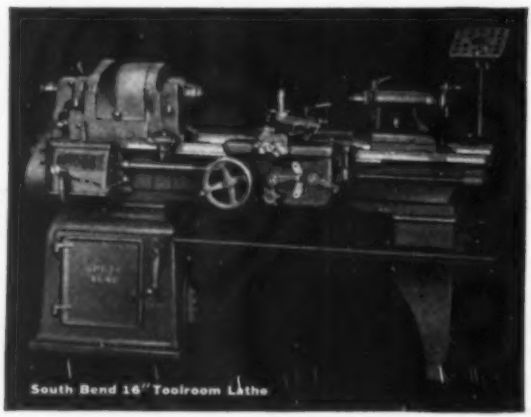
Handwheel Draw-in Collet Atta is ideal for production and toolroo that requires extremely close tole



Center Rest and **Follower Rest** for supporting long bar work while turning, threading, drilling, boring, etc.



4-Way Turret Tool Block permits four cutting tools which simplifies for repetitive operations.



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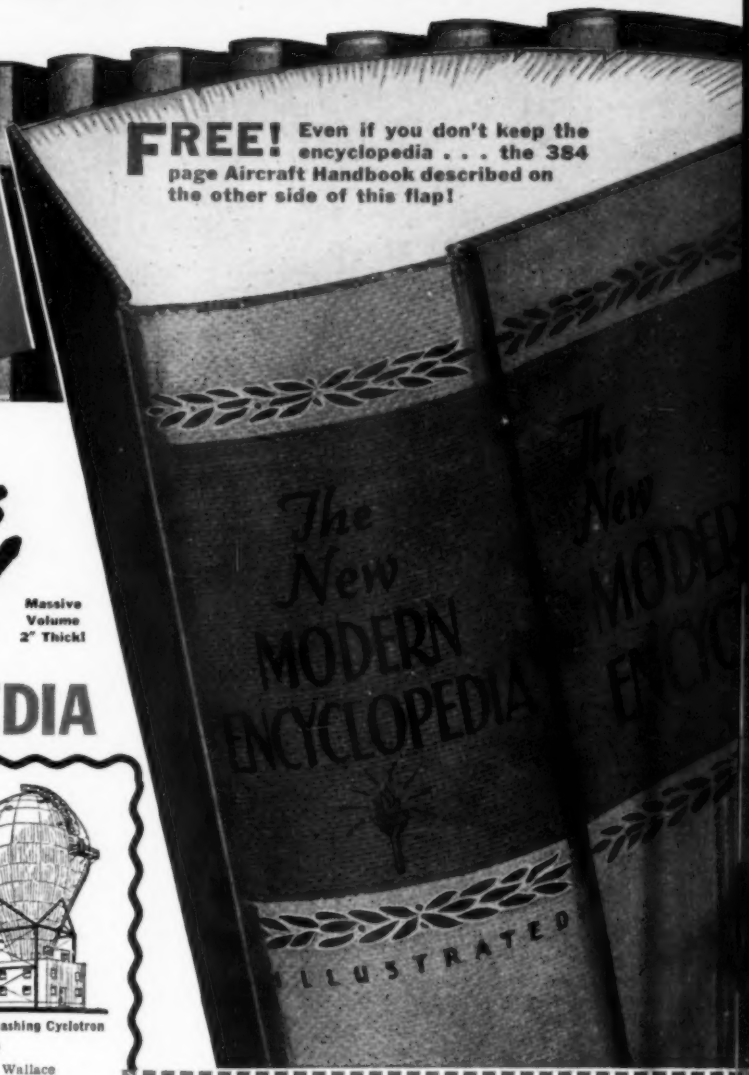

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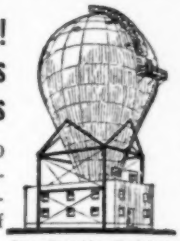

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